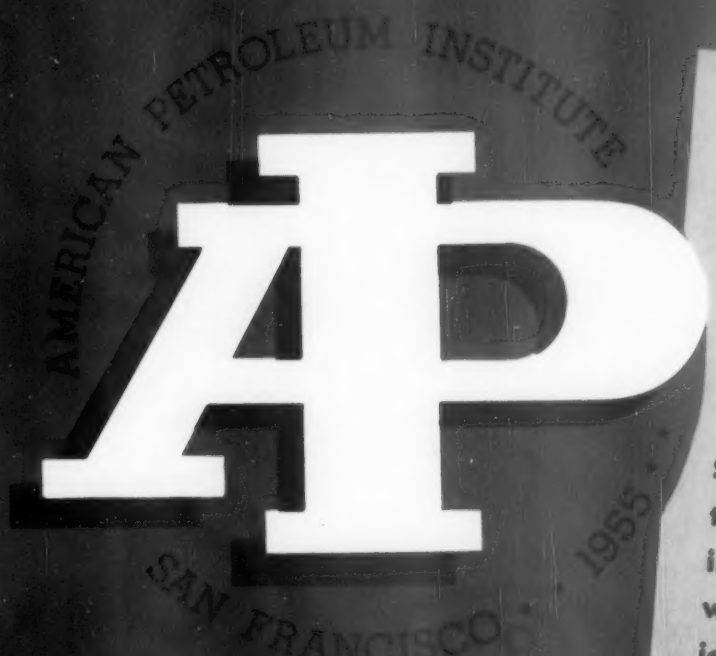
the OIL AND GAS JOURNAL

NOVEMBER 21, 1955



On-the-spot coverage of what happened at world's biggest 1955 petroleum meeting.

Also . . .

Selected papers, both technical and general in interest, and on a wide variety of subjects—from reservoir study to octanes to executive training.

These "condemned" prospects are paying off richly. p. 309

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A glance ahead . . . at press time

These trends will make TOMORROW'S NEWS

Much soul-searching is taking place these days among refiners on what is best route to take to 100 octane and above. New processes are undergoing close economic scrutiny. Pentane isomerization is being examined. Many questions come up, and a leader is: Can we get higher products prices for these? All agree on one thing: Whatever route is taken, it will be more expensive.

Look for the sale soon of Houston Oil Co. Six companies have shown an interest and have been invited to submit bids, including one foreign firm. Sale offer results from the desire of the majority stockholders to dispose of the company.

Pipeline gas turbines of the future may be operating at 2,000° F. instead of 1,400°, resulting in much greater efficiencies. Use of pure molybdenum for turbine wheels will make this possible. Molybdenum keeps its strength at high temperature much better than steel but is subject to rapid oxidation. Efforts now being made to develop a metallic spray coating to whip the oxidizing problem, allowing designers to make full use of the molybdenum.

Look for more commercial tests on fluid coke. Two recently reported tests have proved successful, and more industrial users are showing interest. Once the fluid coke is ground, it burns satisfactorily if fired with an auxiliary fuel.

Dehydrogenation, an old refining process, may be scheduled for another appearance in the limelight. Refiners are eyeing dehydrogenation processes for making ethylene, propylene, and butylene, petrochemical feed stocks. At least one refiner is considering dehydrogenation of gasoline-range hydrocarbons to give his finished gasoline a healthy boost in octane number.

A trend may be shaping up in ethylene. Esso Standard's announcement that it will build an ethylene plant at Bayway may mean other plants are planned to get a supply of ethylene in the backyard of chemical companies that use ethylene in making a variety of products. This would be a shift in the present trend of locating ethylene facilities on the Gulf Coast.

Commercial production of nitroparaffins from propane is now underway in this country. The process, which provides for vapor-phase nitration of propane by means of nitric acid, opens up a new field for petrochemicals. The process has been under development for a number of years, but the first U. S. plant using the process commercially has just gone on stream. Look for other plants to be announced soon—interest is high among chemical and refining people.

the OIL AND GAS JOURNAL

NOVEMBER 21, 1955 • VOLUME 54 • NUMBER 29

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EXPLORATION • DRILLING • PRODUCTION • FIELD PROCESSING

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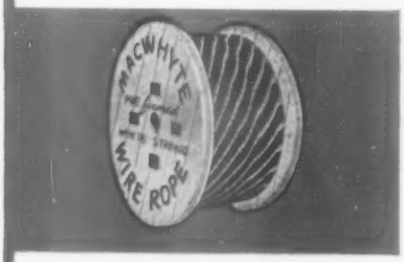

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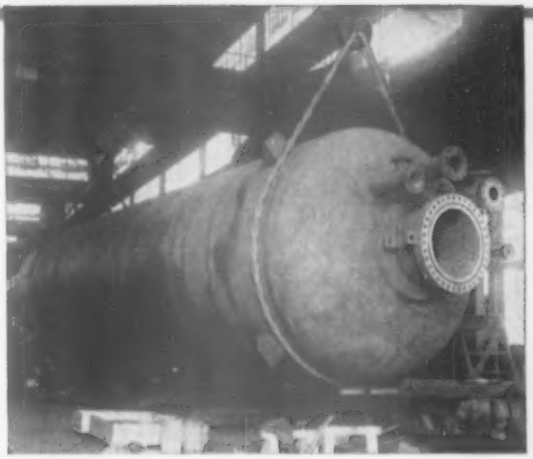
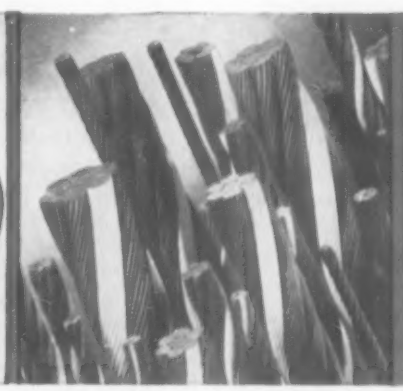


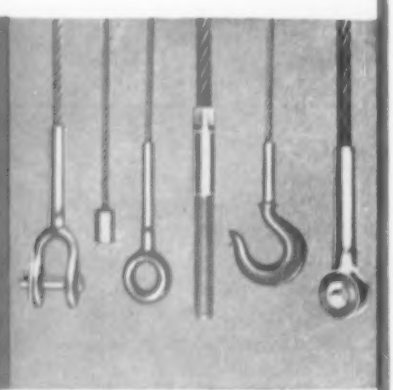
Two Macwhyte Atlas type 1 round-braided slings handling 125-ton refinery vessel.

Macwhyte Drew flat-braided slings handling 12-foot diameter, 66-ton refinery tower.

SLINGS: Macwhyte makes a wide range of sizes and types of Braided and Single-Part wire rope slings. Custom designs are made to meet special needs. For information, ask for Catalog S-8.



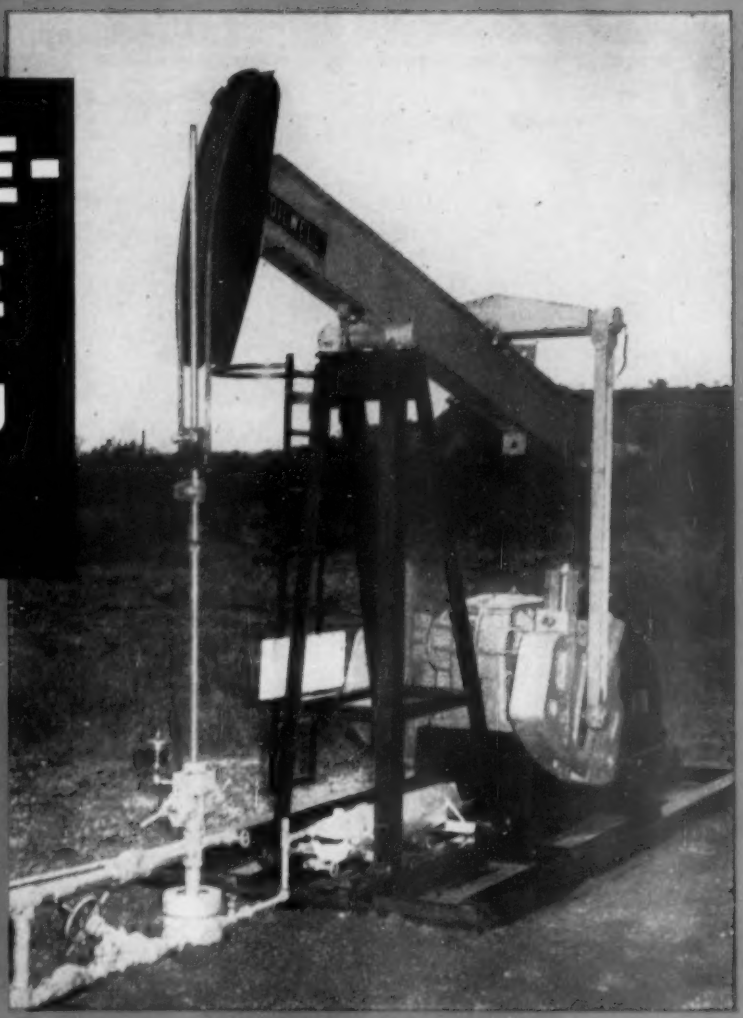
WIRE ROPE: There is a right rope for each equipment need. Catalog G-16 lists all classifications and sizes, also included is general information on handling and use of wire rope.



ASSEMBLIES: Macwhyte "Safe-Lock" Wire Rope Assemblies are made in a wide range of sizes, with fittings permanently attached to one or both ends. Many standard types are listed in Catalog No. 5201.

WIDE-BASE Pumping Units . . .

. . . as well as standard-base types are now included in the "Oilwell" line



YOU CAN SAVE the cost of concrete bases by installing "Oilwell" wide-base pumping units in many instances when pumping speeds are not excessive.

Think what this means to lease operators where production is temporary and pumping equipment may be moved from time to time.

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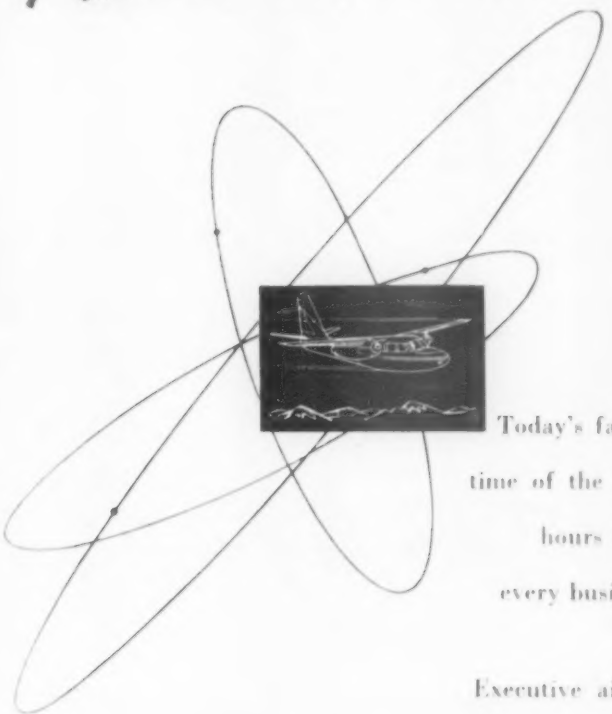

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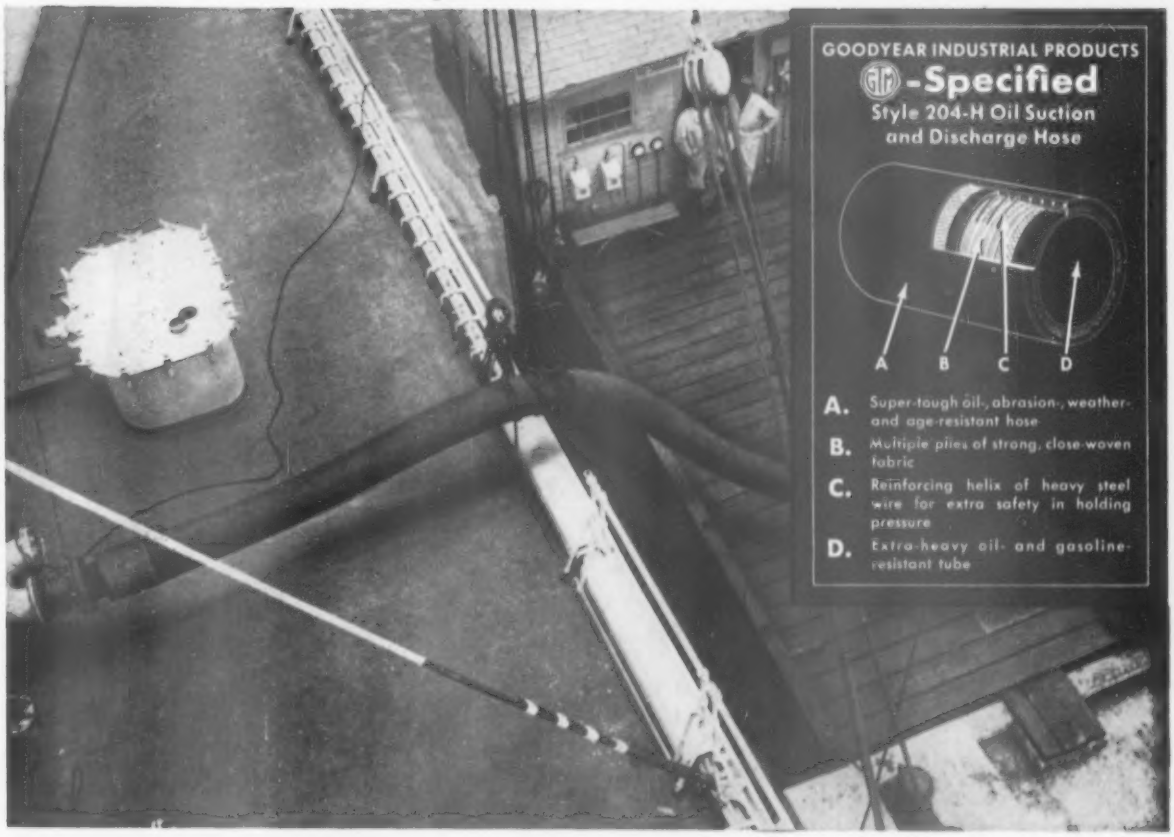
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LINE STRAINERS

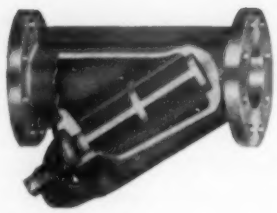
187

Bottom Outlet Type

Is your product absolutely clean, your pump and loading valve protected against scale, grit, dirt and other foreign materials?

Be sure! Use OPW Line Strainers for a contamination free product. Tight fit of cage and screen assures all product passing through strainer. Screen areas are many times pipe size for full flow. The simplicity of screen removal, cleaning and replacing, facilitates regular, periodic checkup in the shortest possible time.

Choose your size, type and mesh! 125-pound standard or 200-pound high pressure types. Bottom or top outlet cage, reinforced for sturdiness and precision-fit. Screwed or flanged end. Flanges, bolts and gaskets to suit. Strainer meshes from 14 to 300.



No. 187-F

Bottom opening type. Heavy cast iron body, 125 pound. Furnished with 40 mesh bronze cage, reinforced screen for gasoline, 14 mesh brass screen for fuel oil.

No. 387

Top outlet type, 125 pound. Heavy ribbed iron body has tapped plug in top section for air relief connection, also bottom drain plug. Both drilled for seal wires.

No. 487-F

Top outlet type 200 pound flanged, drilled and faced on pipe ends with bolted, gasketed cap.

No. 387-F

Top outlet type cage, perfect for pit application. 125 pound flanged, drilled and faced. Cap can be seal wired to prevent tampering.

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SERVING THE UNITED STATES AND CANADA

137-I

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The result—complete cost for laying one mile of steel pipe: $263.90. For aluminum: $44.07. Total savings with Kaiser Aluminum pipe and couplers: $219.83!

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Thus, the combination of light, strong Kaiser Aluminum pipe and the new quick-connecting couplers permit a faster, lower-cost installation than ever before possible!

Get in on these big savings now! Your nearby supplier stocks Kaiser Aluminum petroleum pipe in 30-foot lengths of 2, 3 and 4 inch diameters. He also has the necessary couplers and fittings to complete your systems.

Kaiser Aluminum petroleum pipe is roll-formed and induction welded from high-strength aluminum alloy sheet. Design pressure is above 1500 psi, guaranteed test pressure 1000 psi, recommended operating pressure 500 psi, providing a nominal safety factor of 3 to 1. Inside surface is clad with high-purity aluminum to increase resistance to corrosion.

For further information, contact the Kaiser Aluminum sales office listed in your telephone directory or any of the fitting manufacturers listed below. Kaiser Aluminum and Chemical Sales, Inc., *General Sales Office*, Palmolive Bldg., Chicago 11, Ill.; *Executive Office*, Kaiser Bldg., Oakland 12, Calif.

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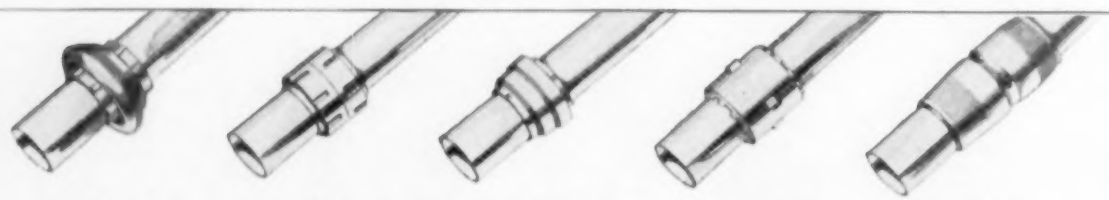
setting the pace—in growth, quality and service



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Ask the rig owners, tool pushers and drillers . . . they'll tell you that torque converter drive on a mud pump reduces pulsation by at least 50% . . . gives *smoother* operation.

Pulsation costs money . . . causes shock loads, stress, and severe fatigue on all moving parts. Twin Disc Hydraulic Torque Converters cushion out vibrations—greatly reduce the destructive discharge variations that are inherent with reciprocating pumps. Or, as one driller very aptly put it: "With mechanical drive there's fluid at *only* one end, and the surge beats on the driven parts—but with hydraulic torque converters, we have fluid at BOTH ends, so there's no more lugging."

Field reports prove time after time that torque converter equipped mud pumps make possible large savings in chains, liners and pistons—with less engine maintenance and downtime. And they give mud pumps a new degree of flexibility. While engines operate at constant speed, torque converters permit varying pump speeds, maintain steadier, higher pressures with a minimum of liner changes.

When *you're* ready to pump more profit out of mud get the facts on Twin Disc Hydraulic Torque Converter Drive. Write Twin Disc Clutch Company, Hydraulic Division, Rockford, Illinois . . . or call the nearest Factory Branch: Dallas (Riverside 3014); Tulsa (Gibson 7-1578); or Los Angeles (Logan 8-3309).

TWIN DISC

TWIN DISC

Torque Converters

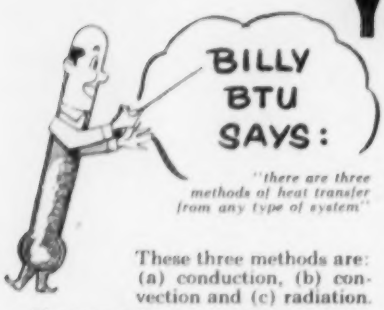
TWIN DISC CLUTCH COMPANY, Racine, Wisconsin • HYDRAULIC DIVISION, Rockford, Illinois

BRANCHES OR SALES ENGINEERING OFFICES: CLEVELAND • DALLAS • DETROIT • LOS ANGELES • NEWARK • NEW ORLEANS • TULSA

Young Heat Transfer News

YOUNG RADIATOR COMPANY, RACINE, WIS.

Utility Cools Compressed Gas with Young Atmospheric Radiators

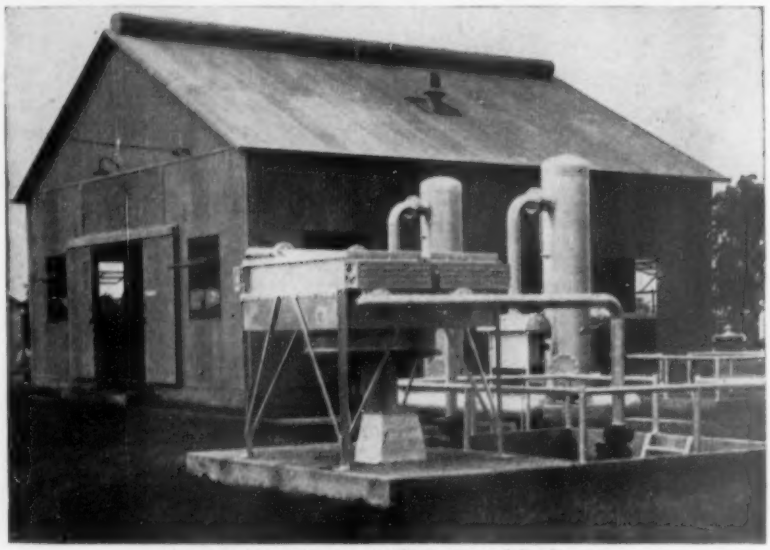


These three methods are: (a) conduction, (b) convection and (c) radiation.

Heat transfer by conduction exists when heat flows within a body from one region of high temperature to another region of lower temperature by simple molecular communication. The amount of heat which can be transferred by conduction is dependent on the temperature difference, thermal conductivity of the material through which the heat is being conducted, the distance between the hot source and the cold sink, and the cross sectional area for heat flow.

Transfer of heat by forced convection depends on the velocity of the fluids over the surface through which heat is conducted . . . by the shape of the surface, by the area through which heat is conducted . . . and by various properties of the fluid as well as temperature difference.

The third general means of heat transfer is radiation. Here heat flows from the body of the higher temperature to the body of the lower temperature through space without any medium within the space. For further details on this subject write for free bulletin: "Heat: Forced Convection Removal From Industrial Hydraulic Circuits" to Young Radiator Company, Dept. 205-L, Racine, Wis.



Young Radiator Company "HC" Cooler and Condenser.

Southwest Natural Gas Company, Ada, Oklahoma, uses Young Radiator Company HC* Horizontal Core Cooler to cool compressed gas stored underground during the summer. Gas is withdrawn during the peak winter loads to supplement pipeline capacity into the City of Ada and nearby points.

Cooling is necessary because higher temperatures are detrimental to the porosity of the formation underground into which the gas is stored.

In addition compressors inside the building are equipped with Young Radiator Company "Mono-Weld" Jacket Water Coolers.

These efficient "HC" Units are also used for cooling water, oil and other gases and for condensing steam and vapors. They combine the efficiency of vertical air discharge with the economy of compact Young design . . . and the versatility of multiple unit combinations. Cooling cores are available in plate fin, Monofin or spiral fin construction for any operating pressure. Fans are mounted independently on special tripods completely eliminating vibration, a major cause of core failure. For full details on "HC" cooling units see your nearest Young representative or write Young Radiator Company, Dept. 205-L, Racine, Wisconsin.

* HC is a Young Radiator Company trademark.

NEW FIXED TUBE BUNDLE HEAT EXCHANGER CATALOG

A complete description of stock and specially engineered Young Radiator Company Type "F" Fixed Tube Bundle Heat Exchangers is given in the newly revised Catalog No. 1254. For your copy, write Dept. 205-L, Young Radiator Company, Racine, Wis.

Young RADIATOR COMPANY

RACINE, WISCONSIN

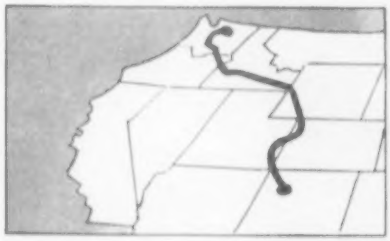
Creative HEAT TRANSFER ENGINEERS FOR INDUSTRY

Heat Transfer Products for Automotive, Aviation and Industrial Applications.

Heating, Cooling, Air Conditioning Products for Home and Industry.

Executive Office: Racine, Wisconsin, Plants at Racine, Wisconsin, Mattoon, Illinois

NEW HIGH-TEST PIPELINE UNDER WAY FROM NEW MEXICO TO THE PACIFIC NORTHWEST



A giant new artery of steel is growing in the West—the 1422 mile Pacific Northwest Pipeline—to carry natural gas from the San Juan Basin in New Mexico to serve the great Pacific Northwest. Consolidated Western's new Utah plant—centered in the "hub of the West"—is the key source of high-test 22" and 26" diameter welded steel pipe for this great project.

Pipeliners have learned that they can depend on Consolidated Western's high-test line pipe. They know Consolidated Western's controlled quality manufacturing results in the high strength, ductility, good welding properties, uniform diameter and wall thickness, that assure ease of installation plus maximum service and safety per ton of steel.

Combining quality control and 100 years of engineering and fabricating leadership, Consolidated Western Steel division United States Steel Corporation, is your primary source of supply for 20"-36" high-test line pipe.

Please direct inquiries to: Consolidated Western Steel, Pipe Sales Office, P.O. Box 2015, Terminal Annex, Los Angeles 54, Calif.

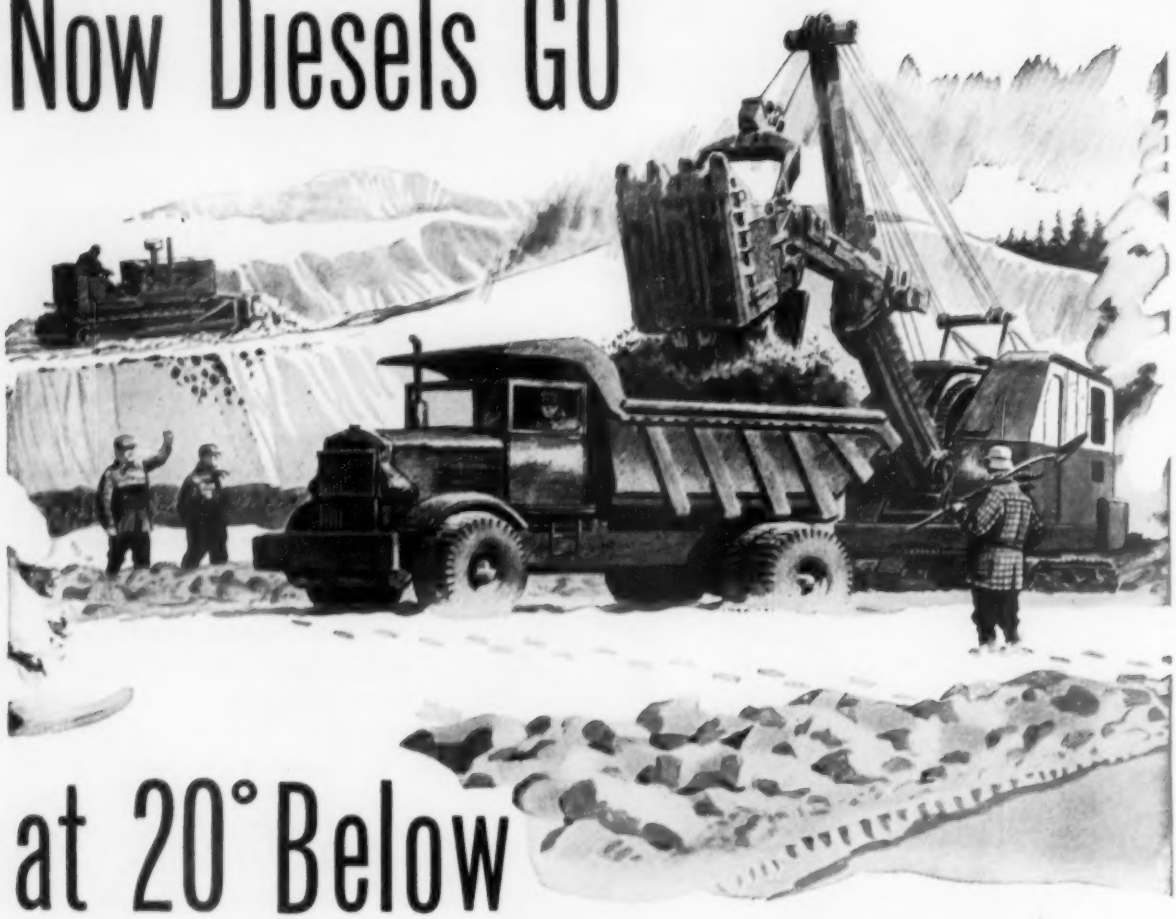
CONSOLIDATED WESTERN STEEL

Sales Offices: Los Angeles, San Francisco, Fresno, Bakersfield, California; Phoenix, Arizona; Seattle, Washington.

DIVISION

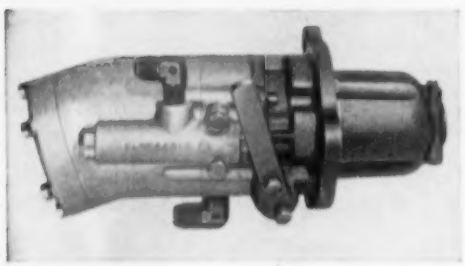
UNITED STATES STEEL

Now Diesels GO



at 20° Below

New Hydrostarter Spins Engines Faster



Heart of the Aeroproducts Hydrostarter is this hydraulic starting motor which spins a Diesel twice as fast as battery-operated starters.

Now, before winter sets in with a vengeance, is the time to put a new, low-cost Aeroproducts Hydrostarter on your Diesel.

Even at 20° below zero, this hydraulic starting system gives you quick, sure starts on every Diesel up to 300 horsepower no matter how long your equipment has been standing idle. The motor delivers maximum torque at all temperatures to overcome starting inertia.

It replaces conventional starting systems, frees you from many maintenance problems and costs less to operate.

And it sells for a far lower price than any other nonelectric Diesel starter available today.

Your Diesel engine or equipment dealer can install an Aeroproducts Hydrostarter on your Diesel in just a few hours' time. He can give you full information—or quickly get it for you. See him today or write direct for full details.

General Motors engineering leads the way

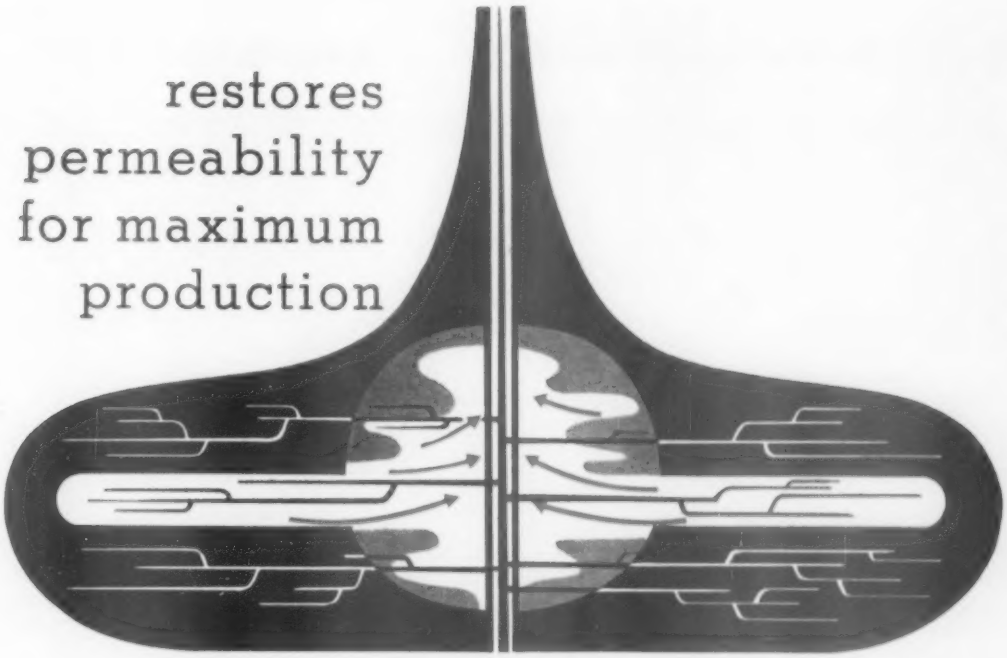
GM GENERAL MOTORS

Building for today...Designing for tomorrow

Aeroproducts

ALLISON DIVISION OF GENERAL MOTORS, DAYTON, OHIO

restores permeability for maximum production



HALLIBURTON'S *DOUBLE ACTION*

MCA

Original permeability has been restored in both old and new wells through the exclusive chemical action of Halliburton's Mud Cleanout Agent – thereby increasing oil flow and, thus, more profitable production.

MCA gets its *double action* power from a combination of hydrochloric acid and a highly active surfactant called Morflo. This double action dissolves the calcareous content of muds, shrinks and disperses clays, destroys existing water blocks and breaks water-oil emulsions. Field use has demonstrated the value of MCA in either limestone or sand formations. MCA actually shrinks water swollen particles of bentonite and frees absorbed water. It changes bentonite into non-expanding particles that will not rehydrate. Acting as a disperser, MCA breaks down mud cake and penetrates deep into the formation. Its wetting properties as a surfactant reduce fluid surface tension and destroy any water blocks or water-oil emulsions.

Reopen your pay zones, restore original permeability for maximum production from your well with field proved MCA. Call your local or district office of the Halliburton Oil Well Cementing Co.

COMPLETE DATA SENT ON REQUEST
Add this valuable information to your Halliburton Service File

HALLIBURTON

CHEMICAL SERVICES

250 SERVICE CENTERS—JUST MINUTES AWAY FROM ANY RIG

Cut maintenance costs. . . increase pipe life

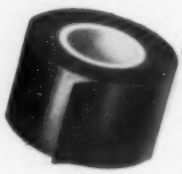
with proven performance. . .

Johns-Manville Pipe Protection Materials

On job after job, pipe line men rely on these three Johns-Manville products to fight pipe line corrosion:

Transhield Asbestos Felt—This low cost pipe line protecting wrapper is specially designed to increase pipe life under average soil conditions. It is reinforced with continuous glass yarns, parallel spaced on ¼" centers to give tear-free application strength. Made of coal-tar saturated asbestos, it acts as a continuous barrier to shield pipe line enamels from earth loads and soil stresses.

#15 Asbestos Pipe Line Felt—A heavy-duty material particularly suitable for severe soil conditions or where a heavier material than J-M Transhield is desired. Provides long life, toughness, flexibility, resistance to rot, decay, cracking, and impact. J-M #15 Asbestos Felt now protects more than 100,000 miles of oil and gas pipe lines. Widths 2" to 36". Rolls any length desired.



Trantex® Polyvinyl Tape—A widely used coating where ease of application is important . . . over field-welded joints of mill-wrapped pipe . . . for rush coating needs. Pressure-sensitive . . . sticks to pipe on contact, forming a firm, stable bond. Can be cold-applied by hand or with simple wrapping machines. In rocky soils, an outer wrap of J-M Transhield or J-M #15 Asbestos Pipe Line Felt is recommended.

For further information about Johns-Manville Products for Pipe Line Protection, write to Johns-Manville, Box 60, New York 16, N. Y.; in Canada, Port Credit, Ontario.

Johns-Manville **PRODUCTS FOR PIPE LINE PROTECTION**

More Strength

with Autocar . . .
Nut and Bolt Construction

- **Higher strength, heat treated material used.**
- **Bolts are made to fill holes exactly to assure snug fit.**
- **Nuts and bolts are assembled with heat-treated lock washers under both head and nut for a permanent, tight installation.**
- **Nuts and bolts are fundamental to easy, low-cost maintenance.**

...Means more work, longer life, lower cost on the job

Typical of the tough jobs and big loads Autocars handle on and off the road—this Model DC-10264 OH is owned by James Orr, Casper, Wyoming. It has special oil field body.

HAVE you seen the Autocar "Nut and Bolt" demonstration? You have if you've seen Autocars on the job—on the tough jobs, everywhere!

Autocar Quality starts with "Nut and Bolt" construction . . . the use of nuts and bolts in the assembly of all Autocar Trucks. It's typical of the way Autocars are quality engineered to exact operator requirements . . . for more work . . . longer life.

Find out how Autocar cuts transportation costs . . . for years. See your Autocar representative without delay.

AUTOCAR TRUCKS

AUTOCAR DIVISION OF THE WHITE MOTOR COMPANY, EXTON, PA.

AUTOCAR DIVISION
The White Motor Company, Exton, Pa.

Send me facts about Autocar "Nut and Bolt" Construction

Name_____

Position_____

Firm_____

City_____ Zone____ State_____

19L

SUN'S NEW CAT CRACKERS WILL DELIVER BTU TO B&W-OXY-Catalyst Boilers

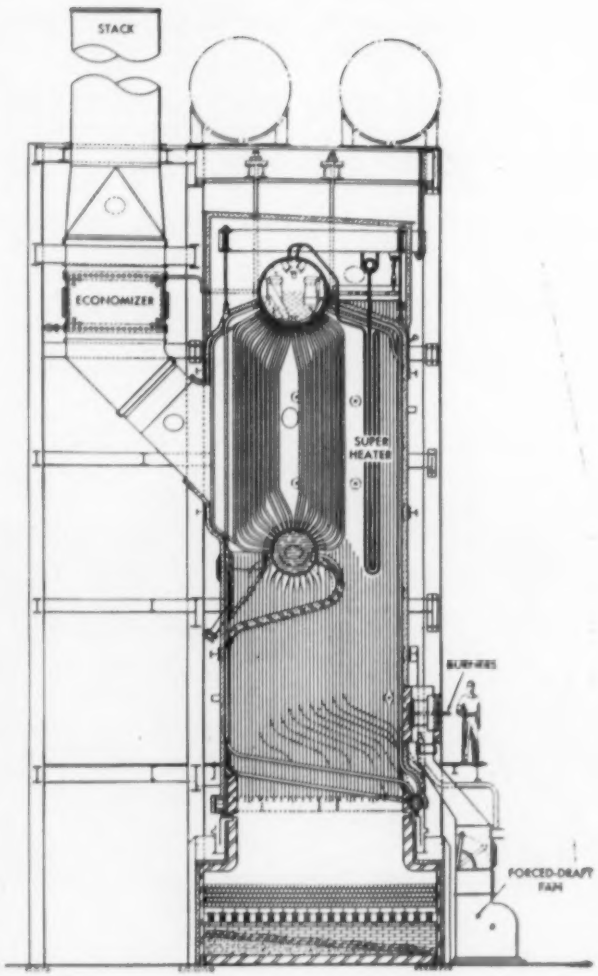
Sun Oil has undertaken an important program of efficiently utilizing the millions of Btu generated in the operation of its catalytic cracking units. Through the use of a new platinum oxidation catalyst, manufactured by Oxy-Catalyst, Inc., the combustibles in the gas streams leaving Sun's new Houdriflow units will be completely burned and the heat absorbed by B&W-Oxy-Catalyst Boilers; thus Sun Oil will save thousands of dollars annually.

Two years ago Sun installed Oxy-Catalyst elements in the exhaust gas stream of one of their fixed bed Houdry units, and proved the feasibility of using the platinum catalyst to burn the combustibles in the cracking unit exhaust gas stream.

This development work resulted in the installation of a Babcock & Wilcox Boiler in Sun's Toledo Refinery especially designed for operation with an Oxy-Catalyst bed. The B&W-Oxy-Catalyst Boiler absorbs the heat from a new Houdriflow cracking unit exhaust gas stream after the combustibles in this stream have been completely burned in the Oxy-Catalyst bed. This unit went on stream in May 1955. A duplicate unit has been completed at Sun's Marcus Hook, Pennsylvania, Refinery, and started operation June 1955.

The Sun Oil Company is spending large sums in its efforts to prevent air contamination and to recover valuable heat otherwise lost to the atmosphere in the air used for catalyst regeneration. The Babcock & Wilcox Company is happy to work with the Sun Oil Company and Oxy-Catalyst, Inc., in this new development which not only accomplishes important fuel savings but also establishes control over the discharge of contaminants to the atmosphere.

The boilers just described are the first of their kind to be installed. Sun Oil also placed one of the first B&W "CO" boilers in operation early in 1954. These boilers burn the combustibles in cracking unit exhaust gas streams by burning supplementary fuel to maintain the proper temperature for combustion in their furnaces. The Babcock & Wilcox Company, therefore, is prepared to quote on and build all types of cracking unit exhaust gas boilers, conventional waste heat, Oxy-Catalyst Boiler or CO Boiler, whichever is necessary to meet your steam and process requirements.



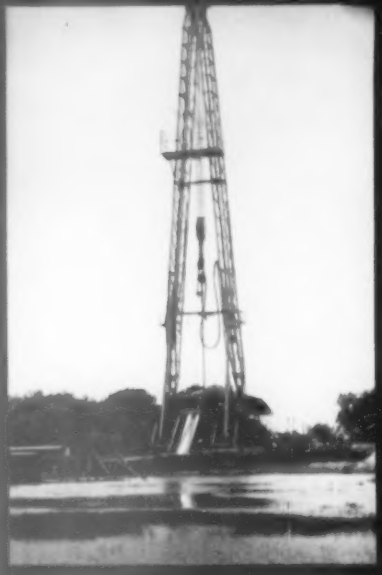
SECTIONAL VIEW OF THE CO BOILERS AT TOLEDO AND MARCUS HOOK

BABCOCK & WILCOX
BOILER DIVISION

G-720

BREWSTER N-12

RESERVE POWERED FOR DEEPEST DRILLING



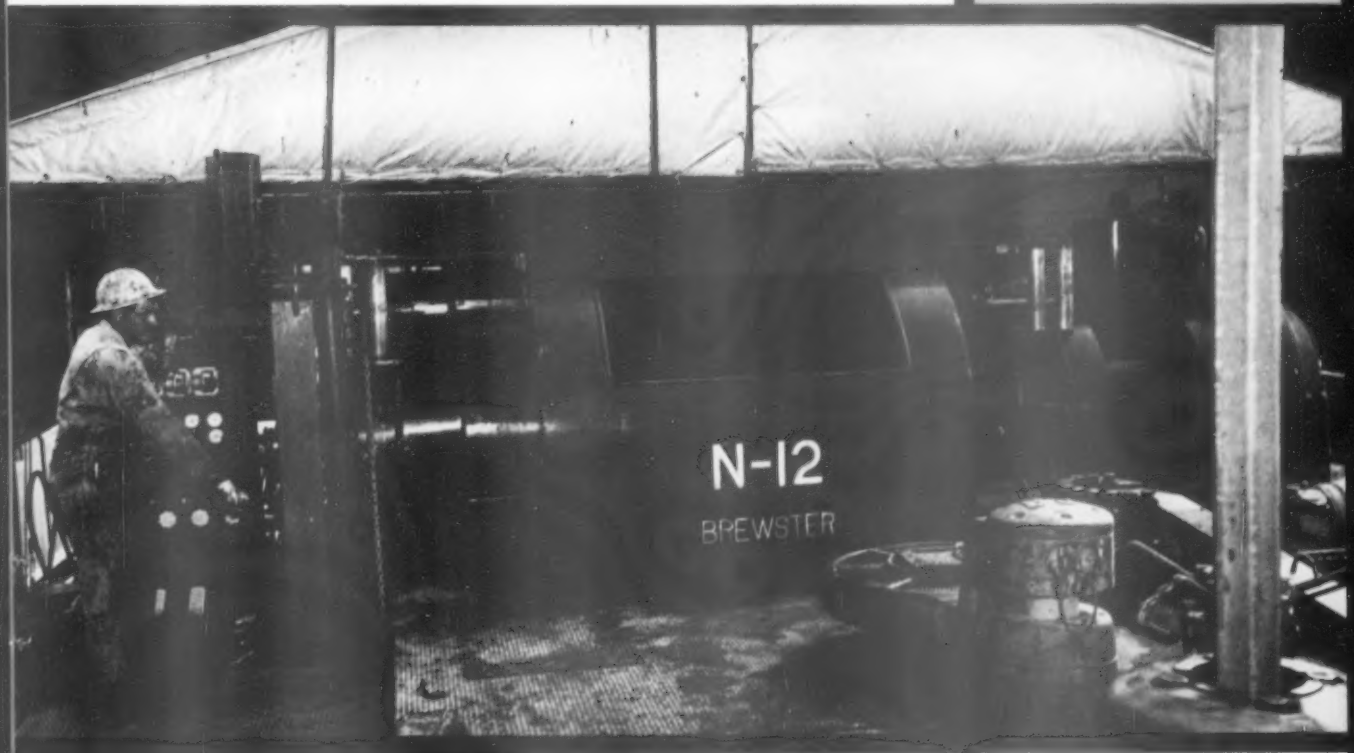
Compact, rugged and responsive, the Brewster N-12 has been specifically engineered to lower deep drilling costs. Every detail from the finger-tip air controls to the heavy-duty box compound and in-line pump drives has been arranged to provide easy handling and maximum portability. The driller can select from any one of eight hoisting speeds to match the load. Without stopping he can instantly shift from low to high. The graduated speed transmission furnishes four forward speeds and a reverse to the rotary. Full engine horsepower can be used at the pumps while maintaining low table speeds.

Each Brewster N-12 is individually tailored to fit the particular needs of the purchaser. They can be ordered with three or four engine compounds . . . with mechanical, torque converter or fluid coupling engine drives . . . for single or multiple level set-up.

Over-the-road moves have been simplified by designing the rig to move in three road sized packages. Only one chain need be removed to separate the compound and drawworks. The control panel is mounted on the main skid and moves as an integral part of the drawworks package. Engines are coupled to the compound by Fawick air clutches which also serve as quick disconnects when rigging down.

Before you buy get all the facts on the Brewster Reserve Power features that reduce drilling cost on every depth well. Write today —

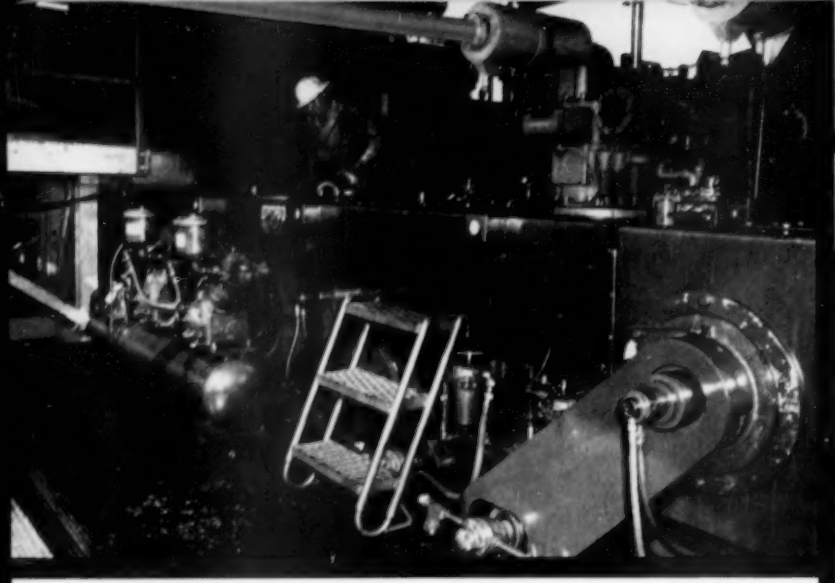
10,000 FT. AND ON DOWN



THE BREWSTER COMPANY INC.
SHREVEPORT, LOUISIANA

FOR EVERY DRILLING DEPTH

N-12 DRAWWORKS



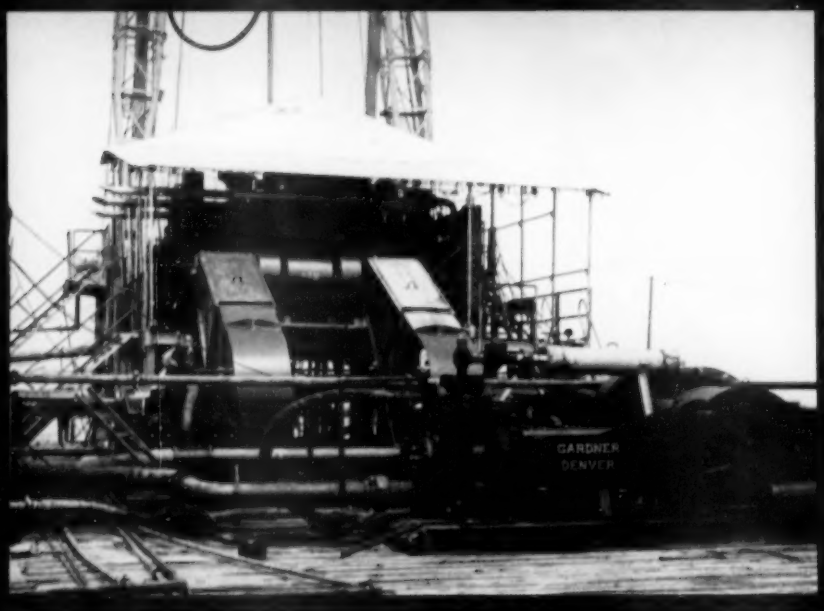
BREWSTER N-12

SPEED DIAGRAM

SPEED	LINE SPEED FPM	LINE PULL LBS.
1	359	124,400
2	501	89,300
3	691	64,800
4	953	47,200
5	1,333	33,600
6	1,850	24,300
7	2,578	17,300
8	3,590	12,400

Line speed and pull based on 1500 H.P./83.3% efficiency.

BOX TYPE COMPOUND—The heavy duty box-type compound can be furnished for three or four engine drive. Large inspection plates provide easy access to all elements. Bearings and shafts are lubricated by a positive pressure system that uses separately driven oil pumps to assure a constant supply of clean oil.



DUAL PUMP DRIVES—In-line pump drives at the rear of the compound simplify rigging up and manifolding—eliminate the need for idlers or notching the substructure. Individual controls permit them to be used singly or together at the same or different speeds.

BREWSTER MATCHED EQUIPMENT FOR THE N-12 INCLUDES:

Brewster 500-ton heavy-duty traveling block. Equipped with Timken tapered bearings, available with five or six sheaves grooved to match your crown block.

Brewster 8-S oilbath swivel. High capacity design with tapered main bearing and Brewster's patented "quick change" packing cartridge.

Brewster RSH-22 oilbath rotary table. Completely mud-proof, the RSH-22 is equipped with top and bottom mud seals. Separate lubrication, oil bath for main gear and bearing and alemite for pinion bearings, assures maximum all-weather protection.

SUPPLY HOUSES

Howard Supply Company • Apex Equipment Company • Bovaird Supply Company Industrial Supply Company • Murray Brooks, Inc. • Reams Supply Company For Canada, Mexico and Export Sales: The Brewster Company

THE BREWSTER COMPANY, INC.

MUELLER®

No. 4 LINE STOPPER UNIT stops-off 10″ and 12″ lines SAFELY!

THE NEW MUELLER No. 4 Line Stopper Units provide a quick, effective, economical means of stopping-off 10″ and 12″ steel lines under pressures up to 500 psi.

Two stopper fittings with a by-pass line may be used to isolate a section permitting tie-in of new or larger lines for greater capacity; relocate lines for greater economy; or isolate equipment for repair or replacement—all without interruption of flow.

Single stopper fittings may be used in conjunction with an existing valve—with or without a by-pass—to perform the same function, or may be used singly to extend lines.

These are just a few of the stop-off jobs possible with the No. 4 Line Stopper Unit.

Contact your Mueller Representative or write direct for full details and specifications.

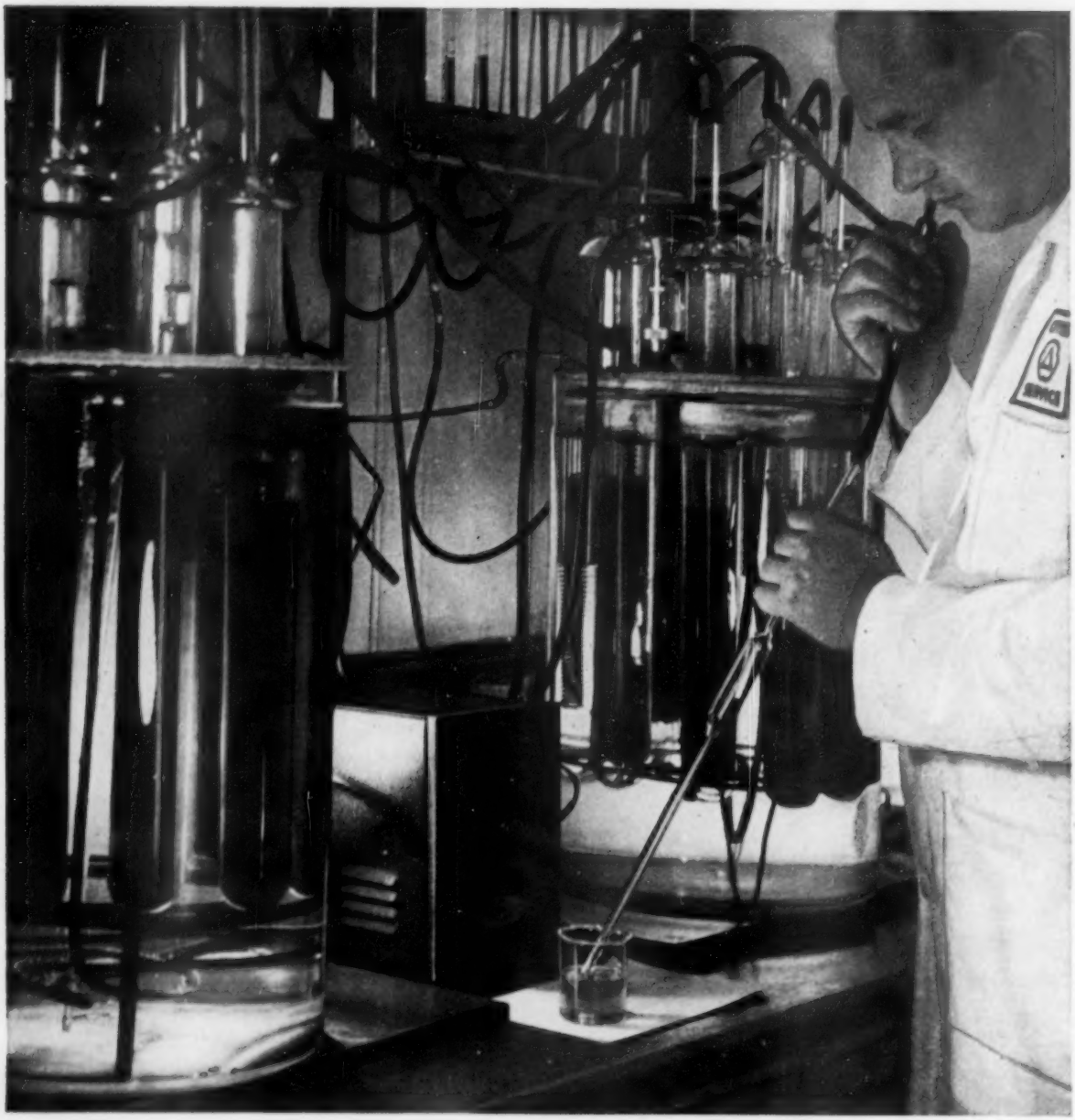
Mueller No. 4 Line Stopping Equipment making stop-off on 12″ crude oil line.

MUELLER CO.

Dependable Since 1857

MAIN OFFICE & FACTORY DECATUR, ILLINOIS

GOING PLACES *into a drop of oil with Cities Service...*

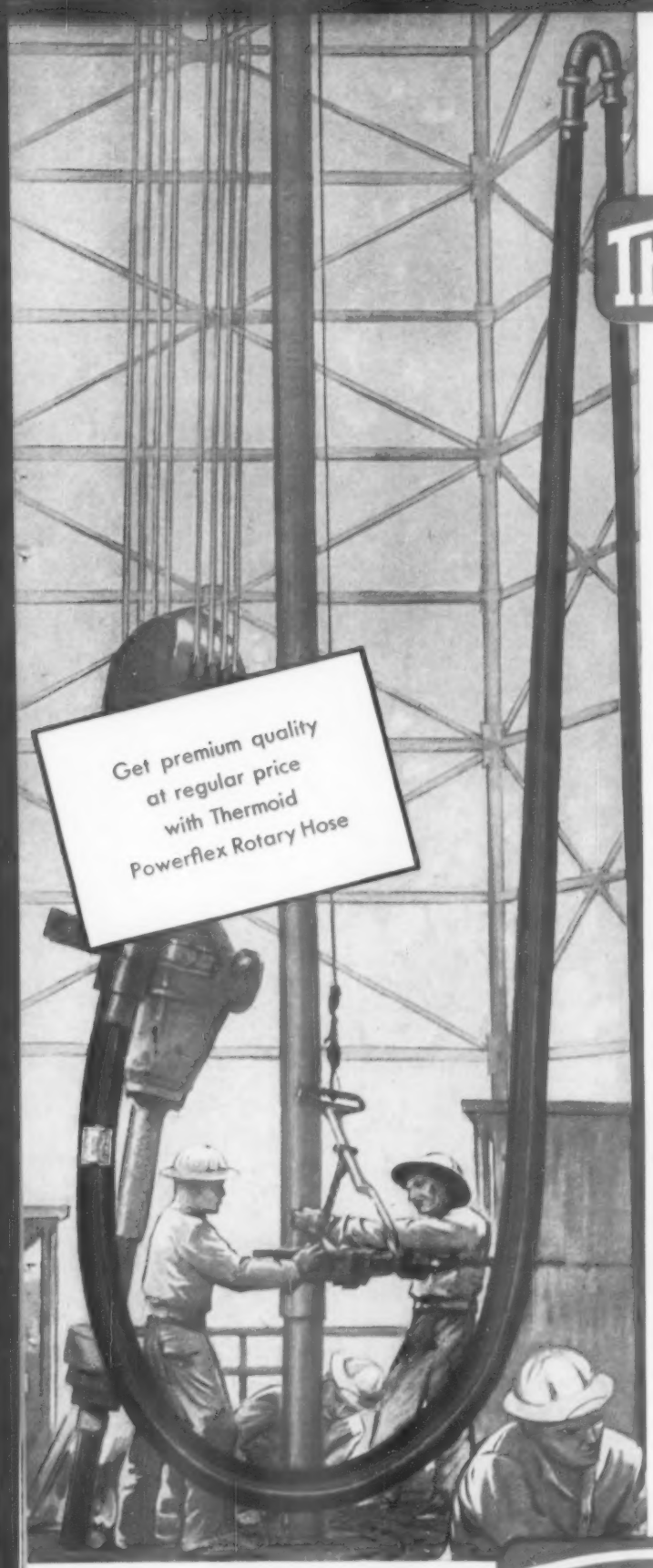


Cities Service researchers enter the minute world of the molecule and come out with new and better products . . . for example, 5-D Premium gasolene and 5-D Koolmotor oil. The superior performance of these new products has boosted sales of Cities Service gasolenes at double the rate of industry demand.

CITIES SERVICE

A Growth Company

Number 15 of a series



Thermoid

POWERFLEX Rotary Hose

. . . the most widely imitated Hose in the oil field!

None have been able to fully match the strength and flexibility of Thermoid Powerflex Rotary Hose.

Powerflex is made of oil-and-abrasion-resistant synthetic rubber, reinforced with impregnated multi-ply woven fabric and high tensile steel cable. Its tough, extra-heavy cover resists weather and abrasion. The materials used in Powerflex are available to any hose manufacturer. But it's the way Thermoid wraps and couples Powerflex Hose that prevents duplication.

Patented full-flow couplings are an integral part of each cable, permanently secured before the hose is wrapped. They are guaranteed and leak-proof . . . positively cannot blow off. Every length is pre-tested to 5,000 psi . . . exceeds all API requirements.

For heavy duty service, always demand Thermoid Powerflex Rotary Hose . . . available in all standard sizes and lengths. Order Powerflex and other Thermoid Oil Field Products listed below, from your nearest supply store or from one of the Thermoid warehouses listed in:

Houston, Texas
Oklahoma City, Okla.
Nephi, Utah
Casper, Wyoming
Los Angeles, Cal.

Thermoid

Powerflex Rotary Hose • Trioflex Slim-Hole Rotary Hose • Mud-Flo Slush Pump Hose • Flexible Discharge Units • F.H.P. and Multiple V-Belts • Oil Country Flat Belting

Wire Line Turn Backs • No-Wip Line Savers • Stuffing Box Rings • All Types of Hose • Molded Specialties • Brake Blocks

Thermoid Company • Offices & Factories: Trenton, N. J., Nephi, Utah

Good Spot for DEPENDABLE equipment

Pure Oil Company has solved its material handling problems on this offshore drilling platform in the Gulf of Mexico with a Bucyrus-Erie 38-B crane. Equipped with a special 12-part boom hoist tackle and a 90-ft. boom, it handles all incoming and outgoing material and equipment — with the dependability desired on such an assignment.

When a well is completed, the 38-B loads all equipment directly into barges alongside the platform. A big derrick barge then moves the 38-B itself to another drilling platform.

On land or water, if your operation can use material handling and excavating dependability like this, get in touch with your Bucyrus-Erie distributor. He will give you complete facts on crawler or carrier-mounted lifting cranes, readily convertible to excavators from ⅜ to 4-cu. yd. 162E55

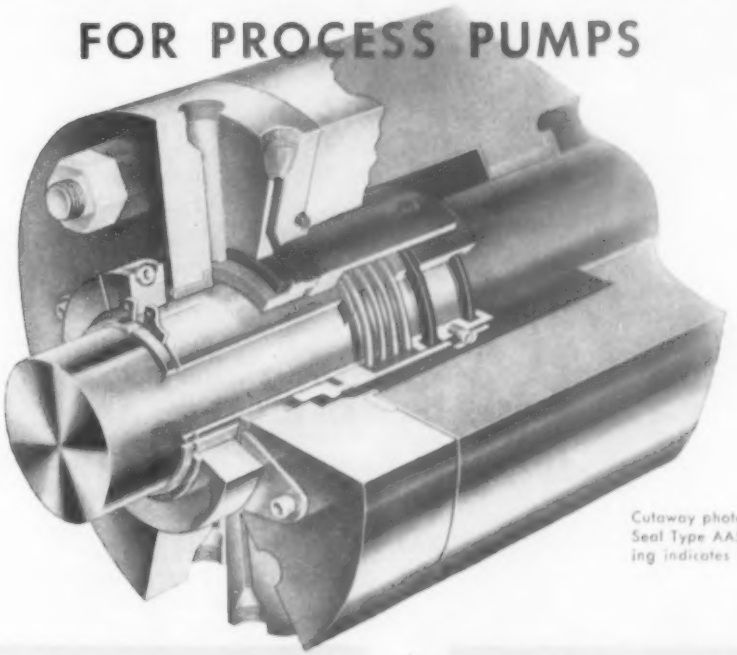
BUCYRUS ERIE
South Milwaukee Wisconsin

1880 75 1955
YEARS OF SERVICE
to Men Who Shape the Earth

NEW from GARLOCK...

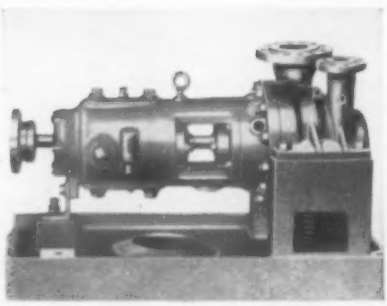
MECHANIPAK* SEALS

FOR PROCESS PUMPS



Cutaway photo of Garlock Unitary Seal Type AA51B-23. Yellow shading indicates liquid being sealed.

- One Piece Assembly
- Quick, easy installation
- Pre-set at factory
- Maintenance-free life



Typical refinery process pump for which Garlock Unitary Seals are designed.

SAVE installation time, eliminate maintenance costs with Garlock's new Unitary Mechanipak Seals for process pumps!

The entire unit, including sleeve and gland, is furnished completely assembled. The seal is pre-set at the factory—no on-the-job adjustments are needed. The *external* lock and drive is readily accessible—eliminates set-screw drive.

Get all the facts today! Phone your Garlock representative or write for new Folder AD-151.

The Garlock Packing Company, Palmyra, New York

Sales Offices and Warehouses: Baltimore, Birmingham, Boston, Buffalo, Chicago, Cincinnati, Cleveland, Denver, Detroit, Houston, Los Angeles, New Orleans, New York City, Palmyra (N. Y.), Philadelphia, Pittsburgh, Portland (Oregon), Salt Lake City, San Francisco, St. Louis, Seattle, Spokane, Tulsa.

In Canada: The Garlock Packing Company of Canada Ltd., Toronto, Ont.

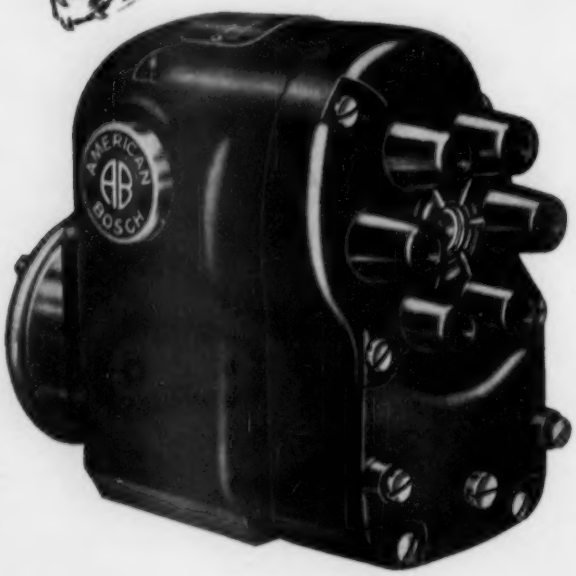
GARLOCK

*Registered Trademark

INSTANT POWER

for dependable ignition

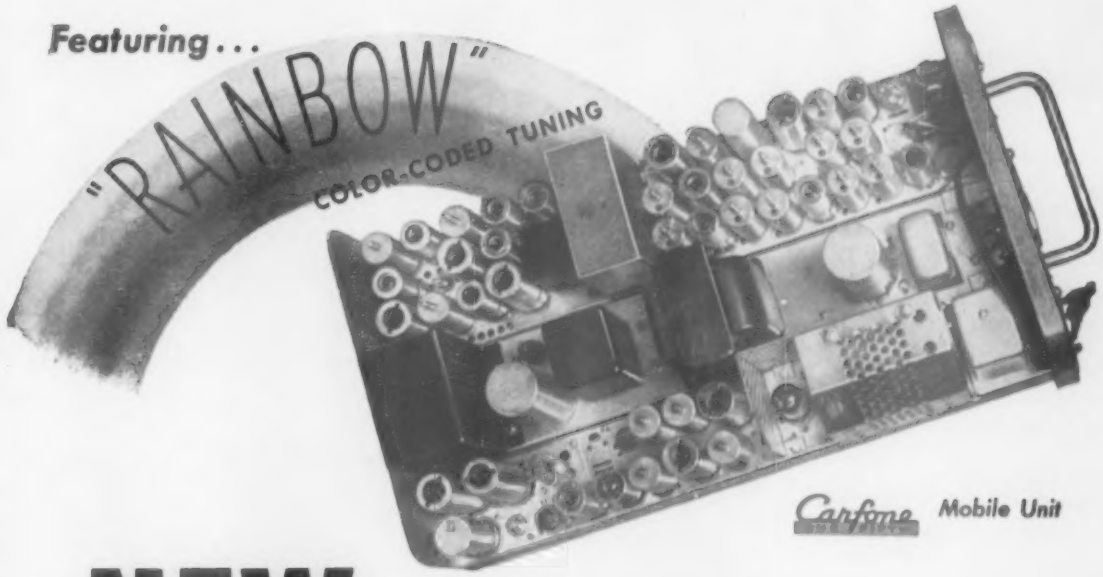
AMERICAN BOSCH MAGNETOS



Better to start with—best in the long run. That's the power-packed story of American Bosch Magnetos . . . today's finest ignition units. Many advanced features give them greater power for split-second starting and premium engine performance PLUS built-in stamina that assures years of constant, trouble-free service in your Drilling, Producing, Pipe-Line and Refinery equipment. That's why they're so widely used as original equipment by many leading engine builders.

For your every replacement need—from the largest, heavy duty engines with either high or low tension ignition, down to today's compact, high-speed power units—there's an American Bosch Magneto precisely engineered for maximum efficiency at all operating speeds and loads. Moreover, American Bosch gives you all the advantages of one of the world's largest and most efficient Magneto Service organizations through your nearby AB Service Agency. Write today for application data on your high or low tension ignition engines. American Bosch, Springfield 7, Mass. A Division of American Bosch Arma Corporation.

AMERICAN BOSCH



NEW RCA 2-WAY RADIOS

The new Carfone "150" and Carfone "450" mobile communications systems are both designed to assure minimum maintenance. You can thank RCA's simplified "Rainbow" tuning for that. Adjustments are reduced to child's-play by easy-to-follow color indications and all-top tuning. And both offer the appearance advantage of dynamic shadow-box styling . . . plus a wealth of advanced engineering features throughout. Complete 6-12-volt convertibility, full all band coverage without change of components, sealed selectivity, compact, sturdy case.

Add up all the advanced features in these two great RCA mobile communications systems and you'll understand why superior performance is the result. And remember . . . the RCA Service Company provides installation and service on a nation-wide basis. Mail coupon below for further information.

DISPATCHER 2-WAY RADIO TO DRIVER

"Get the Best"

RCA

RADIO CORPORATION of AMERICA

COMMUNICATIONS EQUIPMENT
CAMDEN, N.J.

Radio Corporation of America
Communications Equipment, Dept. YD-89, Building 15-1, Camden, N. J.

Please send me more particulars about the new

☐ RCA Carfone "150" 2-Way Radio ☐ RCA Carfone "450" 2-Way Radio

Name .....
Title .....
Company .....
Address .....
City ..... Zone ..... State .....

A finish welder at work on a joint of 10¾" O.D. National Seamless.

ENTIRE SOUTHEAST ALABAMA GAS DISTRICT

22,000 tons of NATIONAL

Coated and wrapped pipe being laid in preparation for back filling.

Bending and welding 10¾" O.D. National Seamless for a creek crossing.

SERVED BY

SEAMLESS Line Pipe

Welders and wrappers at work on a portion of the 10¾" O.D. main line.

THE Southeast Alabama Gas District, consisting of 24 communities, will be served by a 330-mile "U" shaped system of USS National Seamless Line Pipe, designed by Goodwin Engineers, Inc., of Birmingham, Alabama.

The new main line ties into Southern Natural Gas Company's line approximately 12 miles south of Montgomery. It runs south to Brantley, then turns eastward at Andalusia and continues through Enterprise to Dothan. From Dothan it runs north and ties back into Southern Natural's line a few miles south of Opelika, Alabama.

The total 22,000 tons of pipe were made up of 6⅝" O.D., 8⅝" O.D. and 10¾" O.D. National Seamless. It was transported to the installation site in Alabama by both barge and rail from plants in Ohio and Pennsylvania.

USS National Seamless Pipe is chosen consistently for the most challenging of cross-country pipeline jobs. Engineers know from past successes, like the "Big Inch" and the Straits of Mackinac crossing, that the best line installations are accomplished with National Seamless. Its high strength, complete uniformity, and a flexibility that lets it absorb ground pressures and bending stresses keep it trouble-free, even under the most punishing conditions.

IN GAS LINES TOO SEAMLESS DOES IT BETTER

NATIONAL TUBE DIVISION
UNITED STATES STEEL CORPORATION, PITTSBURGH, PA.
COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO
PACIFIC COAST DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

USS

National Seamless Pipe and Tubes

WALLS WITHOUT WELDS

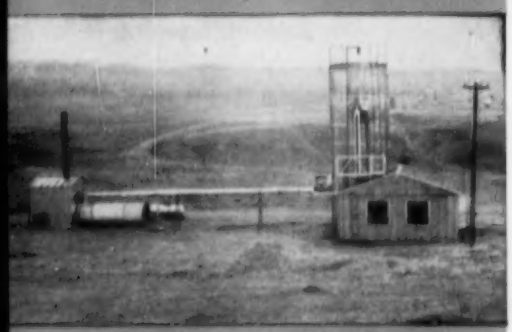
UNITED STATES STEEL

Here's The *Improved* BS&B Model "J" and "JCW" Treater!

. . . For Those "Toughest Of All" Treating Jobs!

The BS&B Model "J" and "JCW" Treater has always been known for its efficiency in handling those "tight emulsion" treating jobs—and for delivering the oil to the stock tank free of water and in a stable condition to prevent excessive gravity loss.

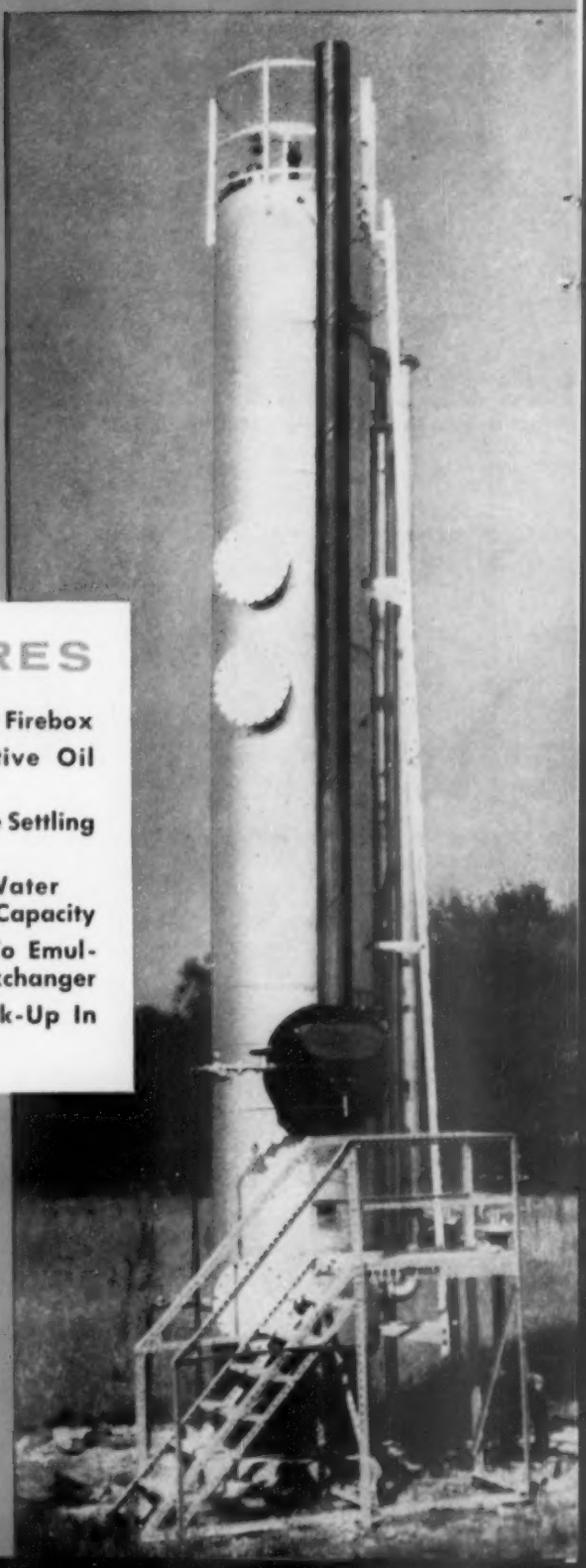
Now comes an *even better* Model "J" and "JCW" which incorporates all of the high performance and easy operating features known to the modern treating industry—a treater for those "toughest of all" treating jobs!



For operation in extremely cold climates, the Model "J" Treater may be modified as in the above installation with extra "weather protection." It then becomes a Model "JCW".

FEATURES

- ✓ Large Efficient Firebox
- ✓ Highly Effective Oil Spreader
- ✓ Large Effective Settling Section
- ✓ Large Free Water Knock-Out Capacity
- ✓ Efficient Oil To Emulsion Heat Exchanger
- ✓ Ease Of Hook-Up In The Field

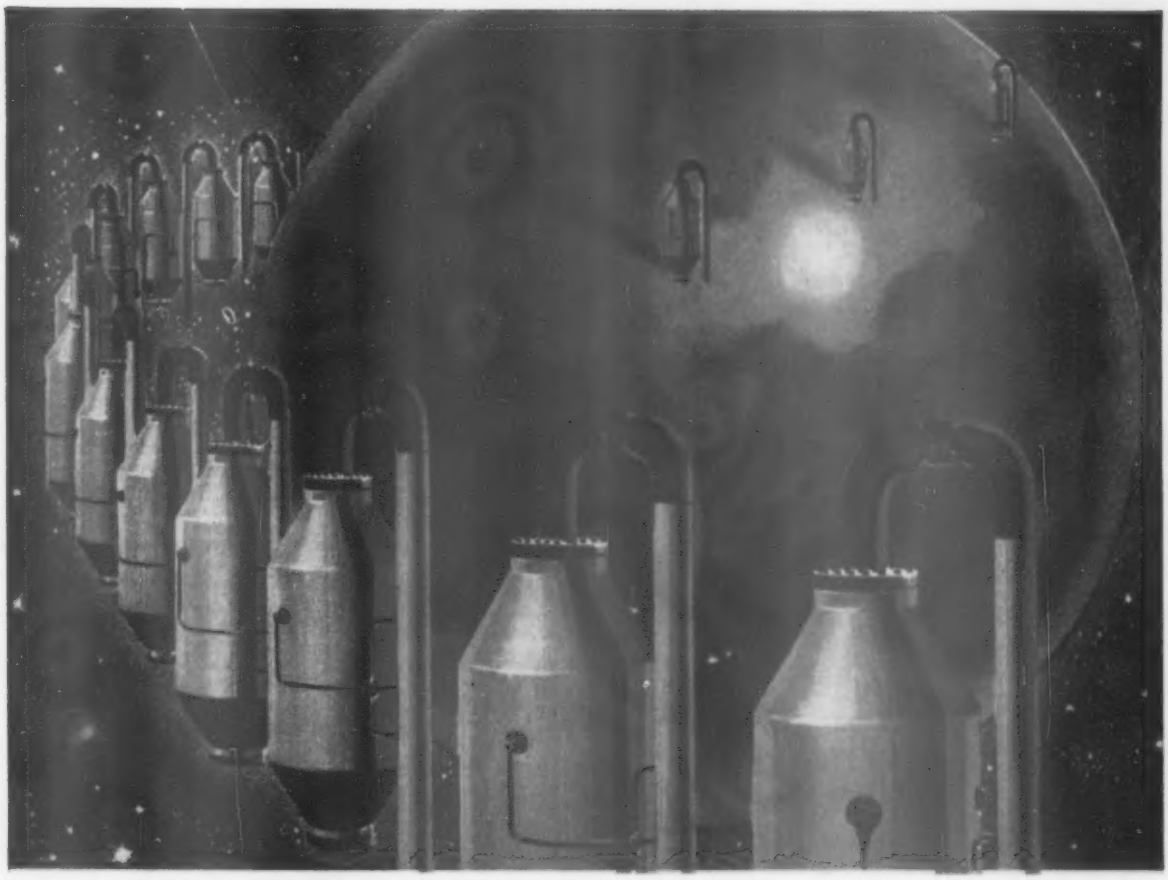


For full details on the BS&B Improved Model "J" and "JCW" Emulsion Treater, contact your BS&B Representative, or write to . . .

BS&B — Efficiency — Reliability — Another Example of Product Leadership

BLACK, SIVALLS & BRYSON, INC.

Oil & Gas Equipment Division,
Dept. 1-A11A
1708 West Main Street
Oklahoma City, Oklahoma



Now...Thanks to Catforming...

HIGH OCTANES, HIGH YIELDS AT LOW COST!

Today, well into its third year of commercial operation, Atlantic's Catalytic Reforming Process is proving its ability to give superior results on a broad variety of feed stocks.

Catforming's simplicity brings savings through increased efficiency every step of the way—actually cutting out many intermediate steps.

Regardless of the size of your operation or the nature of your charge stock, Catforming merits your attention. One reason Catforming has "proved out" commercially is Atlantic's broad experience in all phases of petroleum refining.

Phone or write for our detailed brochure, "CATFORMING." The Atlantic Refining Company, Research and Development Dept., P. O. Box 8138, Philadelphia 1, Pa.

it's the CATALYST that counts

ATLANTIC

2 BIG REASONS WHY MAJOR PIPELINES

Low Maintenance

Bingham Pipeline Pumps are of "Double Volute" design, insuring perfect radial balance of the rotating element. This "Hydraulic Radial Balance" eliminates the unequal pressures on the shaft that are the primary cause of wear and maintenance in conventional pumps.

"Double Volute" design also makes possible a more compact multi-stage design, resulting in reduced load on case boltings. Dual-stage cross-overs, *possible only* with "Double Volute" construction, reduce the axial space between stages, effectively decreasing the overall length of the pump shaft and the span between main bearings. All this adds up to *low maintenance* and trouble-free service.

Long Seal Life . . . "Hydraulic Radial Balance" eliminates shaft deflection, permitting mechanical seals to establish and maintain a *uniform* "Track" between the contacting faces.

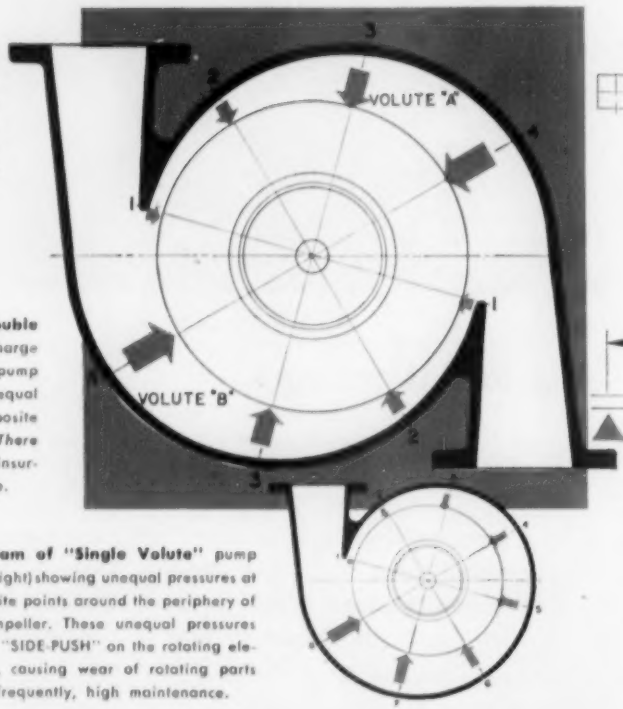
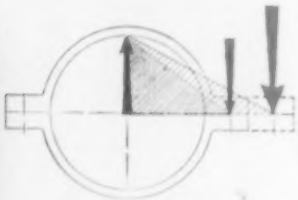
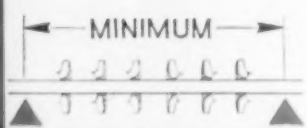


Diagram of a "Double Volute" double discharge case of a multi-stage pump (right) showing the equal pressure on the opposite sides of impeller. *There is no* "SIDE-PUSH", insuring low maintenance.



Greater Compactness in multi-stage "Double Volute" design reduces load on case bolting.



A Wide Range of Operating Speeds Is Possible because "Double Volute" construction reduces the overall length of pump shaft and the span between the main bearings.

Diagram of "Single Volute" pump case (right) showing unequal pressures at opposite points around the periphery of the impeller. These unequal pressures cause "SIDE-PUSH" on the rotating elements, causing wear of rotating parts and, frequently, high maintenance.

NEW MAJOR PIPELINES *recently placed into operation equipped with Bingham "Double Volute" pumps:*

- **Interstate's Southern Main Pipeline**
- **Kaneb Pipe Line**
- **Mackinac Pipe Line**
- **Magnolia's Reinggold Pipeline**
- **Trans-Mountain Pipeline**
- **Trans-Northern Pipeline**
- **Tuscarora Pipe Line**
- **Standard Oil of Indiana Pipelines:**
  1. **Dubuque—Moorhead Pipeline**
  2. **Mandan—Moorhead Pipeline**
  3. **Whiting—River Rogue Pipeline**

NEW MAJOR PIPELINES *under construction being equipped with Bingham "Double Volute" pumps:*

- **Brazilian Gov't Pipeline**
- **Cherokee Pipeline**
- **Great Lakes Pipeline**
- **Interprovincial Pipeline**
- **Lakehead Pipeline**
- **Minnesota Pipeline**
- **Oklahoma-Mississippi River Pipeline**
- **Pembina Pipeline**
- **Service Pipeline**
- **Southern Pacific Pipeline**
- **Spanish Air Base Pipeline**
- **Sun Pipeline**
- **Tidewater Associated Pipeline**
- **Western Pipeline**

SELECT *Bingham*

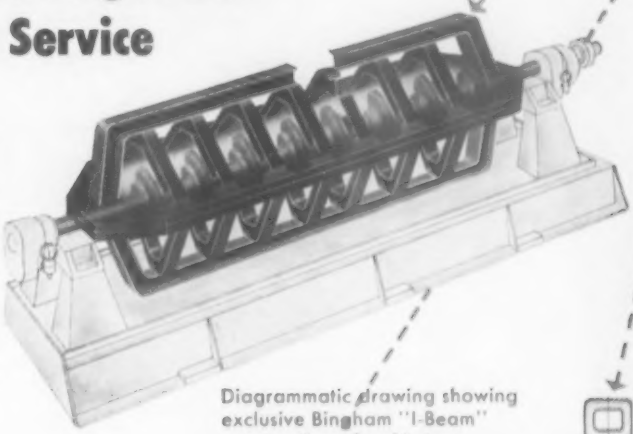
"DOUBLE VOLUTE" PUMPS

I

2 Assured Case Strength for High-Pressure Service

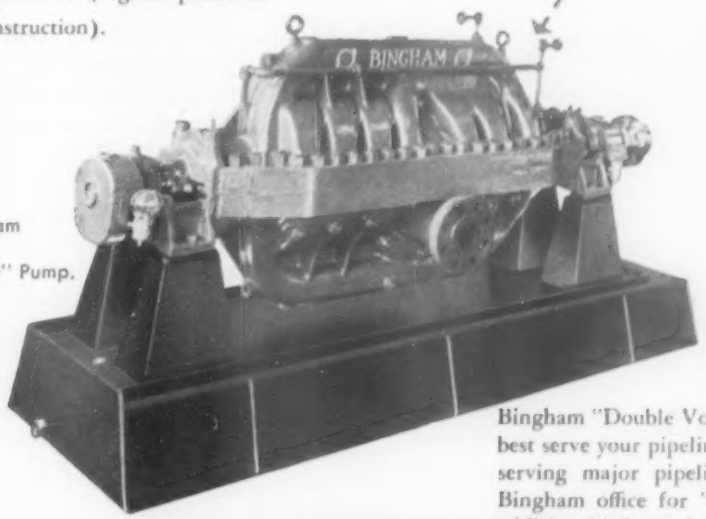
Integral cross-overs in Bingham "Double Volute" multi-stage pumps produce casings of maximum strength for high pressure service because each cross-over is cast integrally with its half of the pump casing, and thereby becomes a structural member of Bingham's "I-Beam Truss Construction".

This feature, found only in Bingham pumps, increases the strength of the pump casing to such an extent that it can safely withstand pressures up to 2000 psi with standard construction (higher pressures with special construction).



Diagrammatic drawing showing exclusive Bingham "I-Beam" construction of multi-stage "Double Volute" pump.

A transverse cross-section of Bingham "Double Volute" Multi-Stage Pumps, showing identical cross-overs cast integrally with the upper and lower halves of the pump casing.



Typical Bingham Multi-Stage "Double Volute" Pump.

Bingham "Double Volute" Multi-Stage Pumps will best serve your pipeline operations, as they are now serving major pipelines. Write to your nearest Bingham office for "Double Volute" Bulletin or additional information.

Bingham SINCE 1921

DOUBLE VOLUTE PUMPS RADIAL BALANCE

BINGHAM PUMP COMPANY

General Offices: **2800 N.W. Front Avenue, Portland 10, Oregon**

Factories: **Portland, Ore. • Vancouver, B.C., Canada**

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at CF&I Seamless Mill

precision threading is checked microscopically

The job requirements for deep wells demand high strength pipe, and the strength of the threaded connection is in proportion to the body of the pipe. Thus, threading is a critical operation in the production of seamless casing and tubing.

At the new CF&I Seamless Mill at Pueblo, Colorado, the pipe is always rolled to an O.D. large enough to insure a good, full thread. The pipe is precisely threaded by automatic machinery of the most modern design. After this operation, CF&I and customer inspectors meticulously gauge the thread lead, taper, height and size. Then the thread is checked with a thread contour microscope, an instrument that determines absolute accuracy of thread angle and form. Finally, thread lubricant is applied to all threads, the couplings are bucked on power-tight and thread protectors are put on both ends of the pipe.

CF&I Seamless Oil Country Casing and Tubing meet API STD 5A specification and are available in sizes from 2⅜" through 9⅝" O.D. CF&I has complete control of the quality of the materials it uses, and production is carefully supervised through every step of manufacture to make sure that CF&I products meet the exacting requirements of the petroleum industry.

SEAMLESS TUBULAR PRODUCTS
THE COLORADO FUEL AND IRON CORPORATION
Denver, Colorado

CF&I

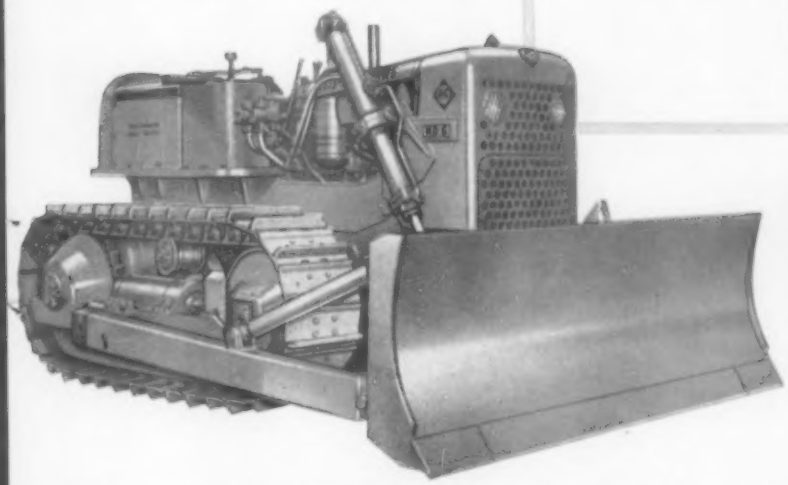
3205

more performance
FOR SUSTAINED HIGH OUTPUT!

more versatility
FOR A WIDER RANGE OF WORK!

more dependability
FOR LOWER JOB COSTS!

ALLIS-CHALMERS ANNOUNCES TWO NEW HD-6 SERIES TRACTORS



HD-6 BULLDOZER-DRAWBAR TRACTOR

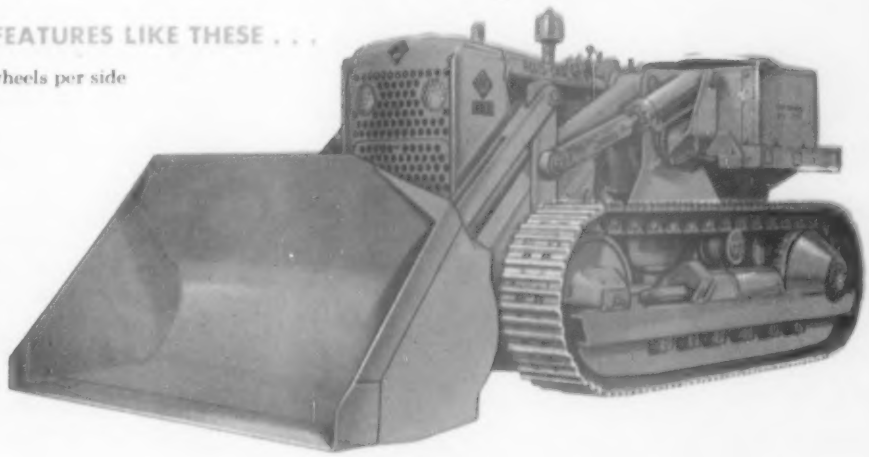
Weight	12,400 lb
Drawbar hp	45
Belt hp	55

STEP UP PERFORMANCE, CUT JOB COSTS WITH EXCLUSIVE HD-6 FEATURES LIKE THESE . . .

- Allis-Chalmers heavy-duty diesel engine
- Long-wearing ceramic master clutch lining
- All-steel box-A main frame
- One-piece steering clutch and final drive housing
- Double reduction final drives
- Roller bearing truck wheels
- Welded steel truck frames
- Tru-Dimension tracks
- 24-volt direct electric starting
- Unit construction
- 1,000-hour lubrication intervals
- Engine-mounted bulldozers

. . . PLUS TRACTOR SHOVEL FEATURES LIKE THESE . . .

- Extra-long track with six truck wheels per side
- New two-position bucket
- Heavy-duty shovel assembly
- Simple, safe hydraulic system
- Two-speed reverse



HD-6G TRACTOR SHOVEL

Weight	19,600 lb
Drawbar hp	45
Net engine hp	57
Bucket capacity	1-1/3 cu yd

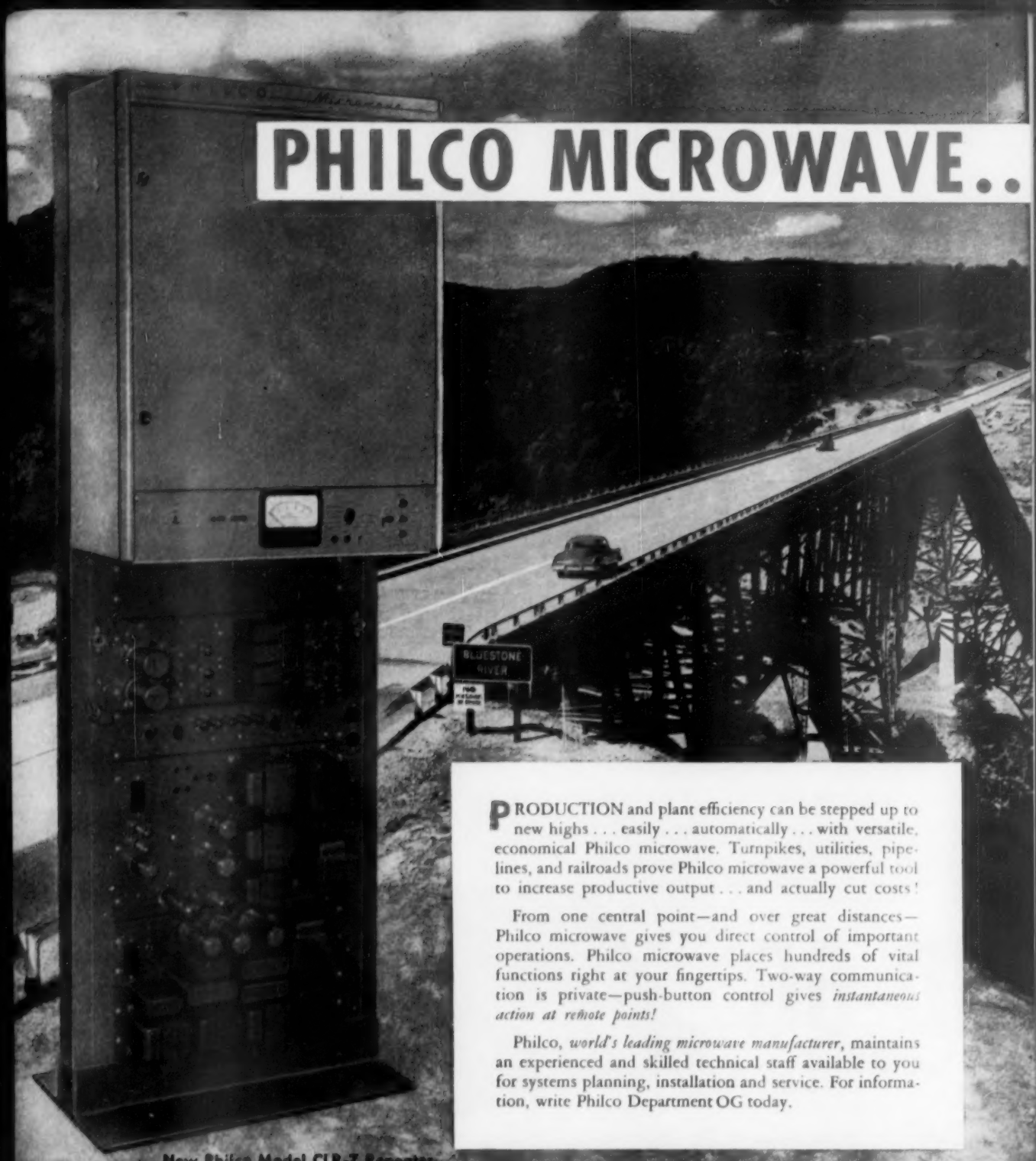
GET ALL THE FACTS NOW FROM YOUR NEARBY ALLIS-CHALMERS DEALER

CONSTRUCTION MACHINERY DIVISION, MILWAUKEE 1, WISCONSIN

ALLIS-CHALMERS

A-C ALLIS-CHALMERS

PHILCO MICROWAVE..



New Philco Model CLR-7 Repeater

PRODUCTION and plant efficiency can be stepped up to new highs . . . easily . . . automatically . . . with versatile, economical Philco microwave. Turnpikes, utilities, pipelines, and railroads prove Philco microwave a powerful tool to increase productive output . . . and actually cut costs!

From one central point—and over great distances—Philco microwave gives you direct control of important operations. Philco microwave places hundreds of vital functions right at your fingertips. Two-way communication is private—push-button control gives *instantaneous action at remote points!*

Philco, *world's leading microwave manufacturer*, maintains an experienced and skilled technical staff available to you for systems planning, installation and service. For information, write Philco Department OG today.

.STEPS UP EFFICIENCY

by Centralizing Plant Control!

TURNPIKES use Philco microwave for traffic control. Over rough terrain, fully automatic Philco microwave systems provide a reliable, low-cost means of communication to meet emergencies, keep highways clear of possible blocks . . . maintain contact with radio-equipped cars and trucks . . . 'round the clock.

Photo courtesy West Virginia Turnpike

PIPELINES use Philco microwave for automatic operation. At this control center, pressures and flow rates of oil, operation of pumps, compressors and telegraphic printers, throughout this 1000-mile pipeline, are monitored and automatically controlled. Duplex voice communication is provided from one location to another.

Photo courtesy Platte Pipe Line

RAILROADS prove Philco microwave dependable. Philco microwave has proved to be a reliable and dependable means of communication, even during floods and storms when vulnerable wire lines have failed. Voice communication, telegraph and teletype are transmitted instantly to remote stations along the route.

Photo courtesy Santa Fe Railroad

PHILCO CORPORATION
GOVERNMENT AND INDUSTRIAL DIVISION • PHILADELPHIA 44 PENNSYLVANIA

PHILCO Famous for QUALITY as Made Today

What one tube steel will give you the best life/cost ratio? *Ask the experts!*

This month's report is on: **DM STEEL**

Has unusually high creep strength for a pearlitic steel, good stability up to 1200° F., fairly good corrosion and oxidation resistance. Has 2 to 3 times the life of carbon steel where corrosion is not severe. Recommended for cracking furnace tubes, hot oil lines, superheater tubes, high temperature steam piping and forgings for accessory parts.

ONE OF 24 TIMKEN HIGH TEMPERATURE STEELS

Carbon	Sicromo 2	Sicromo 5S	18-8 Ti
Carbon-Mo.	Sicromo 2½	Sicromo 5MS	16-13-3
DM-2	2½% Cr.-1% Mo.	Sicromo 7	25-20*
Silmo	Sicromo 3	Sicromo 9M	25-12*
DM	4-6% Cr.-Mo.	18-8 Stainless	35-15**
2% Cr.-Mo.	4-6% Cr.-Mo.-Ti.	18-8 Cb	16-25-6**

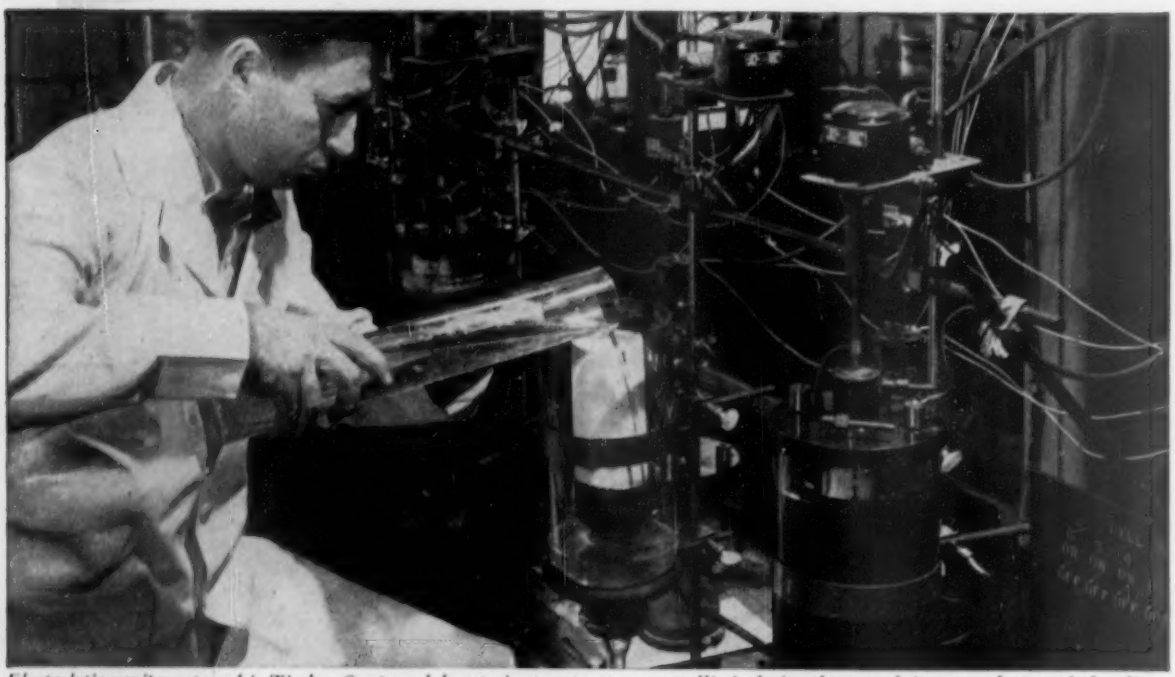
**Available as seamless tubing on an experimental basis only.*
***Not available as seamless tubing.*

THERE are probably several high temperature tube steels that will solve your heat, pressure, corrosion and oxidation problems. But there's only one analysis that will give you maximum tube life per dollar.

To find it, *ask the experts!*

With over 20 years of steel research and experience, Timken Company metallurgists are recognized authorities on high temperature steels. They'll use this experience to help you select from 24 different analyses, pick the one tube steel that will give you the best life/cost ratio. And regardless which analysis you select, you'll be assured of uniform quality because the Timken Company rigidly controls quality from melt shop through final inspection.

Let the Timken Company's RSQ—Research, Supply, Quality—solve your tube problems. *Ask the experts!* The Timken Roller Bearing Company, Steel and Tube Division, Canton 6, Ohio. Cable address: "TIMROSCO".



Electrolytic equipment used in Timken Company laboratories to extract non-metallic inclusions from steels in research on steel cleanliness

YEARS AHEAD—THROUGH EXPERIENCE AND RESEARCH

SPECIALISTS IN FINE ALLOY STEELS, GRAPHITIC TOOL STEELS AND SEAMLESS TUBING

USUAL OR UNUSUAL SPEED INCREASING PROBLEM

FARREL HAS THE "RIGHT" SOLUTION

Normally you can select the "right" speed increaser for your particular installation from Farrel's standard line of 49 sizes, with ratios from 1:1 to 12:1. Units using two sets of gears are supplied for higher ratios—ratio range from 12:1 to 40:1.

If your installation is unusual like the one in the photograph, Farrel will still supply the ideal speed increaser for the job. In the case above, a two-pinion unit delivers 300 HP to each of two pumps from a single 600 HP engine. It steps up the engine speed of 400 RPM to pump speed of 3553 RPM.

How "right" Farrel speed increasers are for any pipeline pumping service can be measured by their performance record over the years. Of the hundreds and hundreds installed since 1932, all are still in operation. And, in addition, service calls have been rare, although many of these units have been operating under the most adverse conditions—continuous heavy-duty service, dust, rain, sandstorms, severe heat and intense cold.

Farrel engineers will be glad to help you choose the "right" gear unit for your high speed application.

Write for information.

FARREL-BIRMINGHAM COMPANY, INC., ANSONIA, CONN.

Plants: Ansonia and Derby, Conn., Buffalo and Rochester, N. Y.
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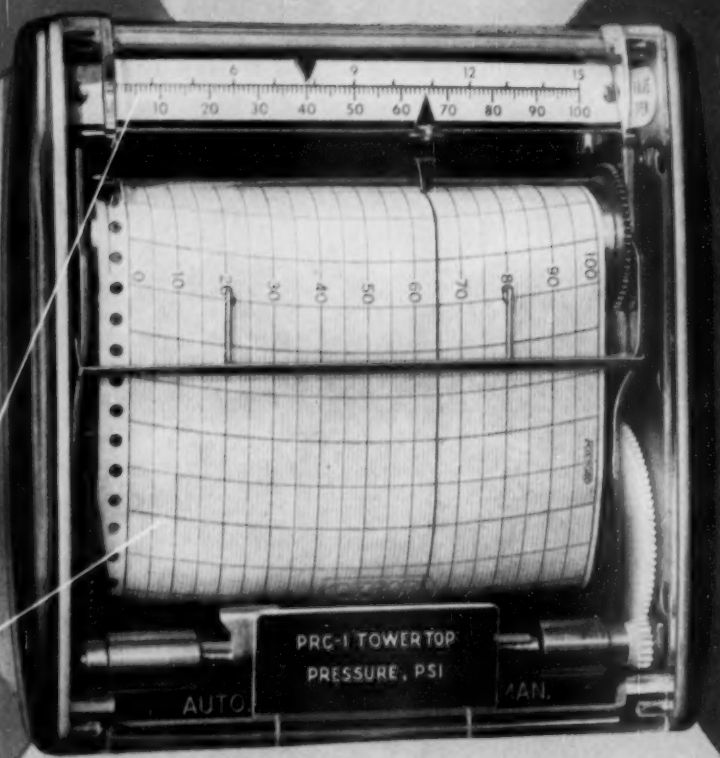
FB-970

NOW...

compactness with nothing sacrificed!



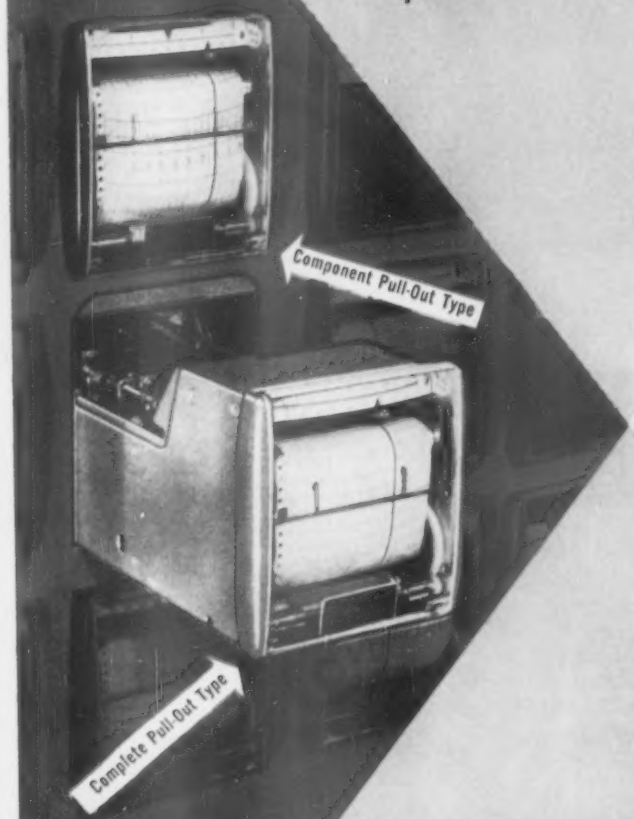
Models to Meet All Your Specifications

In all the following CONSOTROL instruments, recorder and indicator units can be easily converted in field.

- Recording Control Station with automatic/manual transfer
- Recording Control Station with manual loading only
- Recorder — single or two pen
- Indicating Control Station with automatic/manual transfer
- Indicating Control Station with manual loading only
- Indicator — single or two pointer

CONSOTROL

small-case panel instruments



Here's the "tops" in centralized recording and control efficiency! CONSOTROL* Instruments require the minimum of valuable panel space, yet provide unsurpassed operator convenience, visual accuracy, and ease of maintenance . . . maintain the highest standards of precision and dependability. For example: the simple CONSOTROL method of switching from automatic to manual control requires no memory or extra operations . . . never "bumps" the process. All CONSOTROL charts and scales are full 4-inch width for greatest visibility . . . highest accuracy. When it comes to servicing, there's plenty of "finger room" . . . all parts are uncrowded and easily removable. And just compare inking requirements with other designs. CONSOTROL needs ink filling only once or twice a year! These are only a few of CONSOTROL's advanced design features — available in both fixed-mounting and full pull-out type instruments. Get the complete story. Write for Bulletin 13-18. The Foxboro Company, 748 Neponset Avenue, Foxboro, Mass., U.S.A.

*Reg. U.S. Pat. Off.

FOXBORO

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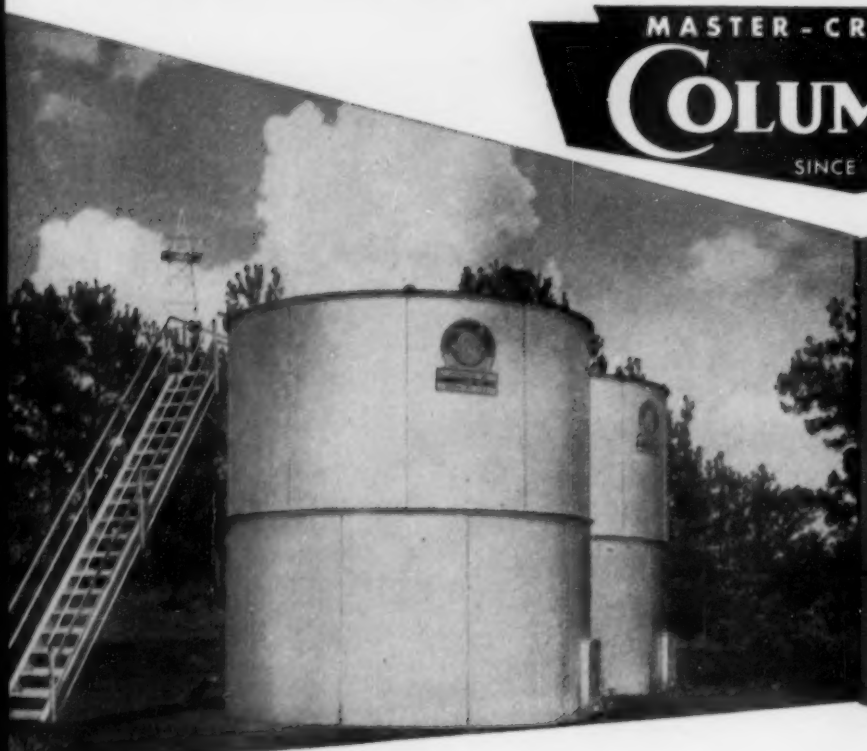
Consotrol Process Control

FACTORIES IN THE UNITED STATES, CANADA, AND ENGLAND

MASTER-CRAFTED BY

COLUMBIAN

SINCE 1893



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for profit

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Continental Tank Company
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Oklahoma City, Oklahoma

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Mapp Tank Company
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Martin Tank Company
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Kilgore, Texas
Continental Tank Company
Midland, Texas
Snyder, Texas
Federal Tank Company, Inc.
First State Bank Bldg., Bellaire, Texas
Houston, Texas
Jackson Equipment Co.
P. O. Box 1625
Wichita Falls, Texas
Westex Tank Company
P. O. Box 941, Odessa, Texas
Columbian Steel Tank Company
(Warehouse) 3705 McKinney Ave.
P. O. Box 18057, Houston, Texas
Texas Gulf Tank Company
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O'Neill Tank Company
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From the first hours saved in erection time to the decades of lasting service there's no more profitable oil storage than Columbian Bolted Steel Tanks. The precision engineered, formed and punched plates and decks go up faster, fit tighter, last longer. More than 61 years of experience in fabricating steel is behind the master craftsmanship built into every Columbian Tank, to give it lasting strength. After years of service, a Columbian tank can be quickly taken down and re-erected at a new location, without loss of quility. Whatever tank size you need, wherever you want to locate it, you can depend on Columbian for fast delivery and high quality.

IN THE FIELD OR AT THE PLANT, you can't do better than a rigid, strong, fire-safe Columbian Metal Building — for pumphouse, storage, warehouse, garage or equipment. Easily, quickly erected with accurately fitting sectional panels. Write for Free catalog and complete details.

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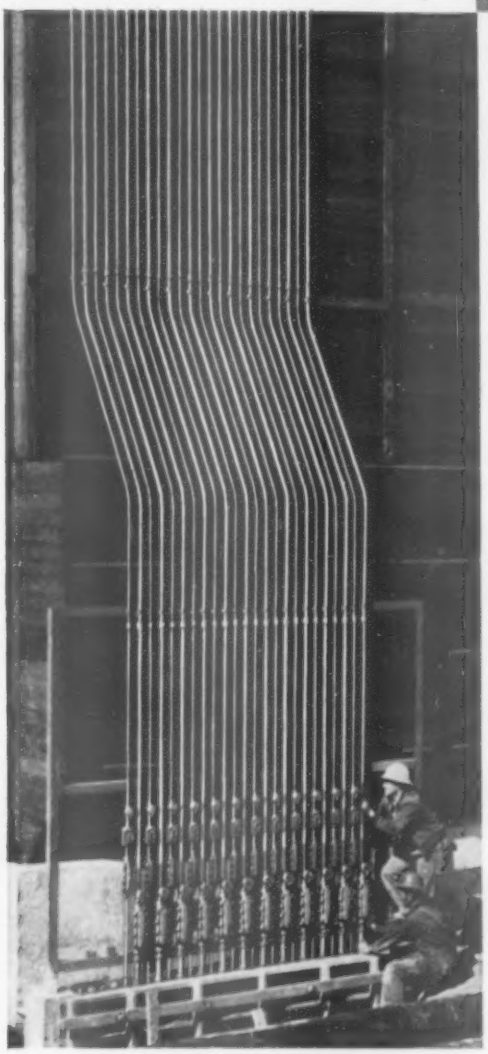
STEEL, Master-Crafted by Columbian... First for Lasting Strength

DOWN a humid 180 feet below water level at Downsville Dam

Some 3600 feet of 2" Everdur Conduit (E.M.T.) protect electric lines in a service shaft plunging down to the release water chamber 180 feet below water level at Downsville Dam of the New York Metropolitan Water Supply System. Electric lines operate vital valves, indicating and communication equipment.

UP in the corrosive air at a water cooling tower



During the War, General Petroleum Corp. saw galvanized conduit fail within a year at one of its plants—replaced it with Everdur Conduit. At its new Ferndale Mobilgas Refinery in Washington, some 12,000 pounds of Everdur Conduit in various sizes guard electric power lines for motors and lighting in this water cooling tower.

EVERDUR Conduit will guard the electric power lines—for years

Everdur* Never Rusts. It offers high resistance to other types of corrosion. That's why Everdur Conduit—made from one of Anaconda's exclusive copper-silicon alloys—is specified for dependable year-after-year protection of electric power lines in industry, on bridges, at power and water supply projects—wherever water and corrosive atmospheres are a problem—or where conduit must be buried or embedded in concrete.

Everdur is Tough. In addition to corrosion resistance, Everdur has high physical strength, resists wear and abrasion. It stands up under movement and vibration, as on a bridge, in a subway, in a factory.

Everdur is Nonmagnetic. Everdur Conduit creates no magnetic field to produce temperature rise in electric power cables.

Everdur Electrical Conduit is available in two wall thicknesses —R.C. in nominal sizes from ¼" to 4", inclusive, and E.M.T. in nominal sizes ⅜" to 2", inclusive. For more detailed information write: The American Brass Company, Buffalo Division, Buffalo 5, N. Y. In Canada: Anaconda American Brass Ltd., New Toronto, Ontario.

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CORROSION RESISTANT • STRONG • NONMAGNETIC • WORKABLE • WELDABLE

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a famous name in the oil fields

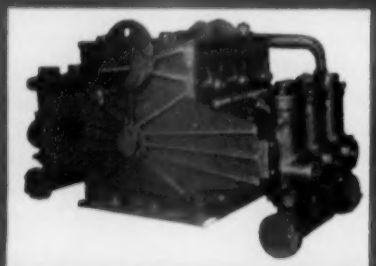
Three generations of oil men have known and respected the Gardner-Denver name on oil and mud pumps. Now Gardner-Denver announces *the quality line* of pumps specially engineered for salt water disposal and water flood service.

★ Full range of discharge pressures and daily capacities to meet any set of field conditions.

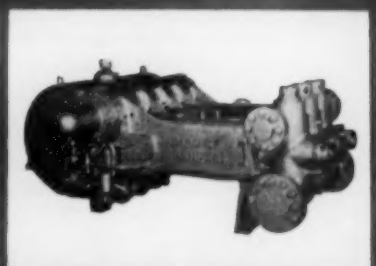
★ Only one source of supply for any water flood pump you need.

★ Take advantage of Gardner-Denver field locations . . . GARDNER-DENVER PARTS WAREHOUSES: Tulsa, Dallas, Houston, New Orleans, St. Louis, Pittsburgh, Louisville, Denver, Los Angeles. In addition, these GARDNER-DENVER SERVICE MEN HEADQUARTERS: Houston, Corpus Christi, Odessa and Wichita Falls, Texas; New Orleans and Shreveport, La.; Oklahoma City, Okla.; Ellinwood, Kas.; Hobbs, New Mexico; Casper, Wyo.; and Edmonton, Alberta, Can.

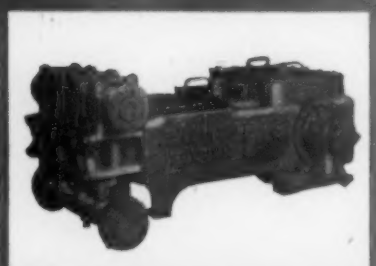
PL-7



PA-8



PE-5



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Export Division: 30 Rockefeller Plaza, New York, N. Y.

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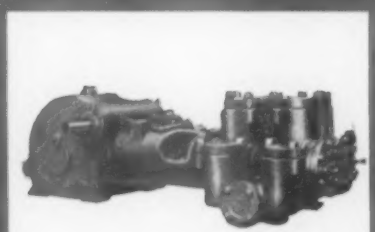
specially engineered for water flood service

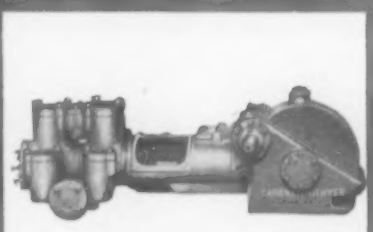
S P E C I F I C A T I O N S

MODEL	PL-7	PA-8	PE-5	FG-FXG	FF-FXF	LE-LXE
Stroke	7"	8"	5"	6"	5"	4"
Pump R.P.M.—up to	120	160	260	140	225	275
Input H.P.—up to	240	160	75	60	40	24
Discharge P.S.I.—up to	3,360	1,455	2,700	895	640	820
Bbl. per day—up to	13,200	9,000	7,300	6,000	4,500	3,000
Plunger or Piston Dia.—up to	4¾"	4½"	4"	4"	3"	2½"
Type	Plunger	Plunger	Plunger	Piston	Piston	Piston
Number of plungers or pistons	6	3	3	2	2	2

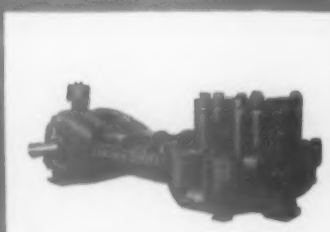
FG-FXG



FF-FXF



LE-LXE



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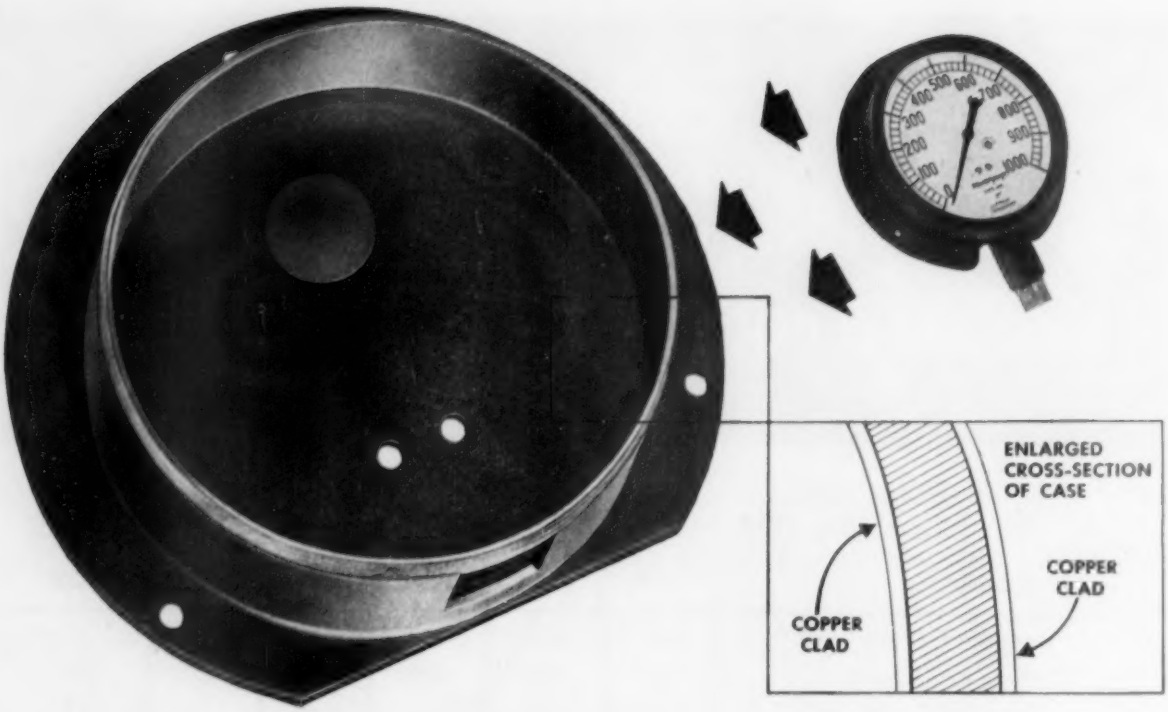

A CASE TO MATCH "Mastergauge" QUALITY

Few products have ever achieved the leadership that has been conceded to the Marsh "Mastergauge." But instead of allowing the "Mastergauge" to coast on its laurels we have kept right on making it better. An example of this is the **NEW "Marshalloy" CASE**

The recently developed case is accurately formed in steel of boiler plate thickness; then heavily copper-clad so that it has the corrosion resistance of a solid copper case with the strength of steel.

Such a case is four times as strong and one-third lighter than conventional cast iron cases. It is finished in a newly developed, corrosion-resistant satin-black enamel that makes it as attractive as it is durable.

The new case is fitted with Marsh safety blow-out plug — another typical Marsh advancement. Ask for information covering gauges for all services.

SOCKET, TUBE AND END-PIECE FUSED INTO ONE UNIT

Just as welded piping is more sound than any mechanical joining, the fusing of the socket, tube and end-piece into an integral unit is the most dependable pressure gauge construction ever known.

Welding these dissimilar parts together is a tricky problem — fully solved by a special process which produces

THE "Conoweld" TUBE

The photo of an actual section through the socket shows the perfect fusion. Instrument men have called this the most significant pressure gauge development in recent years.

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Marsh Instrument & Valve Co. (Canada) Ltd., 8407 103rd St., Edmonton, Alberta

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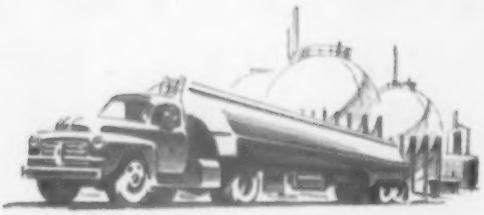
EATON 2-SPEED AXLES keep Trucks on the Job- Reduce Maintenance Costs



By providing a gear ratio best suited for each road and load condition, Eaton 2-Speed Axles permit engines to work in their most efficient and economical speed range, reducing stress and wear on operating truck parts. Truck maintenance is reduced, trucks deliver more on-the-job hours. In addition, because of Eaton's exclusive planetary design, forced feed lubrication, and extra rugged construction, there's less maintenance on the axle itself. When axle repair is required, Eaton's down-to-earth design makes the work quick, easy, and economical. Trucks with Eaton 2-Speed Axles last longer, earn more at lower cost, are worth more on the trade-in.

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HOW TO BUY V-BELTS

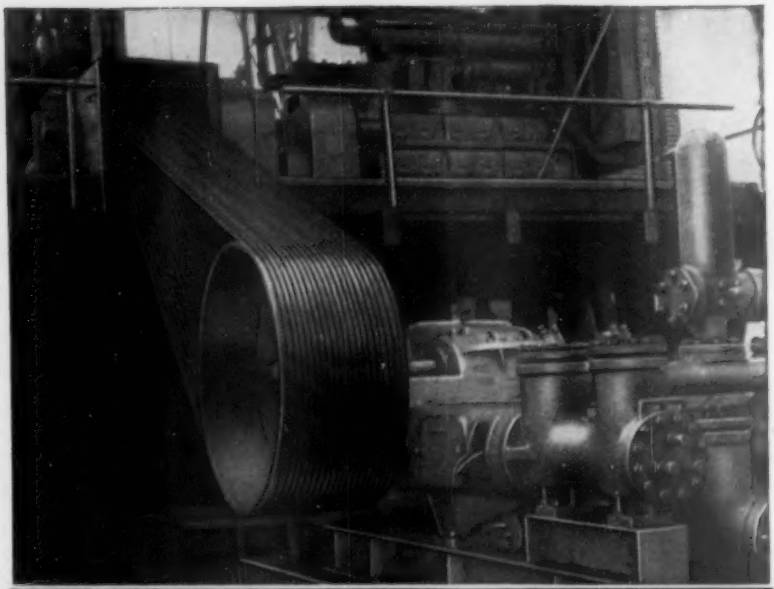
FOR TOUGH, RUGGED DRIVES

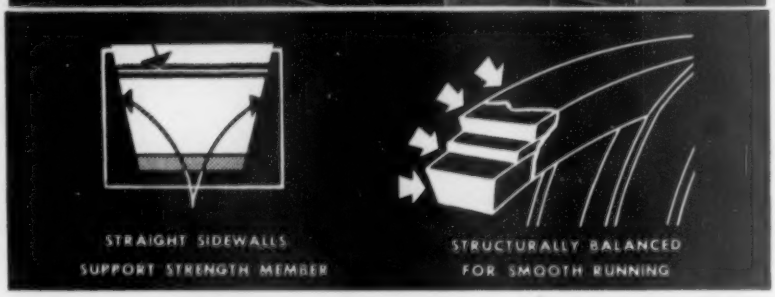
. . . and get

"More Use per Dollar"

Look for a V-belt construction that assures long life under heavy loads, extra strength with the use of the correct strength member.

Higher rig floors and bigger pumps for deeper drilling demand longer, stronger V-belts. Belt strength members of super-strength cords should be correctly positioned in the neutral axis section of the belt so as not to stretch or compress unnecessarily as the other parts of the belt are flexed in use. Straight belt sidewalls help support the strength members in a straight line, permit all cords to pull equally . . . deliver their maximum share of power. The precision balance of *all* parts of the V-belt makes for a smoother running drive, controlled length of every belt in the set, and fewer matching problems . . . longer life with the heaviest power load. Specify by name the V-belt engineered to give you extra strength and extra pulling power for heavy duty drilling operations . . . specify Condor V-Belts.





CONDOR V-BELTS

R/M engineers have developed an improved Condor V-Belt especially to meet the demands of high powered deep drilling rotary rigs. The strength members in Condor V-Belts are made of super-strength synthetic cords . . . embedded at the neutral axis in heat dissipating Flexlastics to assure the smooth, internally cool running of every belt despite constant flexing around pulleys. Prestretching during manufacture removes inelastic stretch that might otherwise occur on the job . . . there are no laggards and no over-strained belts. Matching problems are further eliminated by special humidity protection and individual belt length is controlled. Straight rugged sidewalls grip the grooves with positive pressure for maximum power delivery. Heavy duty covers withstand wear and weather . . . protect the heart of the belt against premature failure. The long service life and uniform power delivery of every Condor V-Belt in the set means more productive operation of your rigs at lower costs.

Let an R/M representative show you how Condor V-Belts last longer on the most rugged V-belt drive . . . give you "More Use per Dollar".

RM 512 OF

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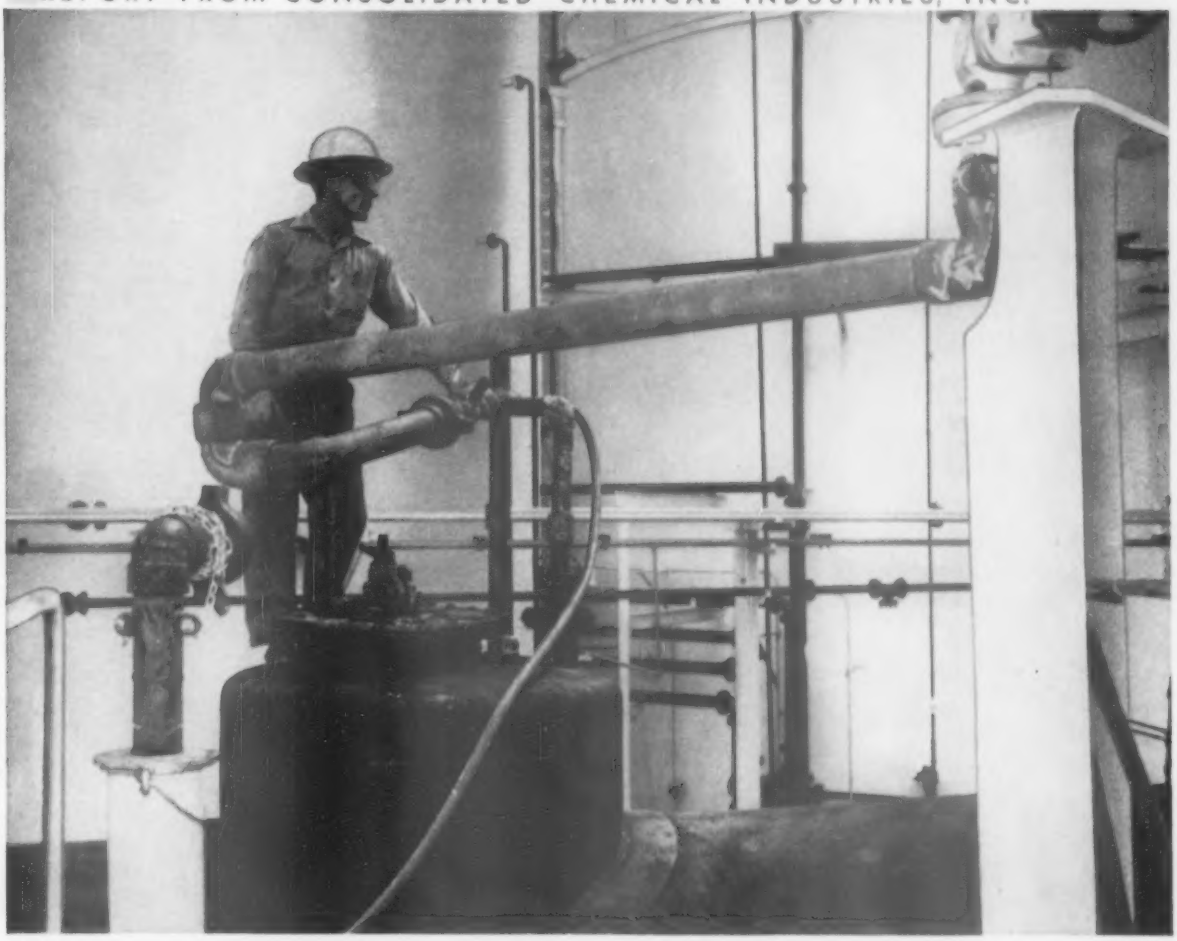
REPORT FROM CONSOLIDATED CHEMICAL INDUSTRIES, INC.



Give your product a SAFE SENDOFF

Use CHIKSAN LOADING ARMS

Consolidated Chemical Industries is safety conscious! They use Chiksan loading arms for tank car loading of sulphuric acid.

To assure complete safety in your loading operations, CHIKSAN manufactures loading arms and ball bearing swivel joints from the same materials used in the piping systems. Steel, malleable iron, nickel-bronze, stainless steel and special alloys are used . . . meeting most chemical requirements. CHIKSAN ball-bearing swivel joints speed the loading and unloading of both liquids and gases . . . safely. Send for your copy of our free catalog which shows complete CHIKSAN lines and standard loading arm designs.

Chiksan Swivel Joints rotate 360° in 1, 2 and 3 planes, handling air, hydraulics, fuels, oils, water and other fluids.

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Superior Engines

provide many profitable, extra drilling hours between overhauls because . . .

Superior Diesel or Dual Fuel Drilling Engines are available from 300 to 650 Continuous B.H.P., Superior Gas Drilling Engines from 320 to 630 Continuous B.H.P.

Great engine accessibility and simple rugged construction make routine maintenance quick and easy—right on the rig! Features such as dynamically balanced crankshaft, heavily reinforced cylinder block, individual cylinder heads and fuel pumps for greater dependability, and sturdy engine bed which takes the Diesel firing thrust, to mention a few, greatly lengthen the time between engine overhauls.

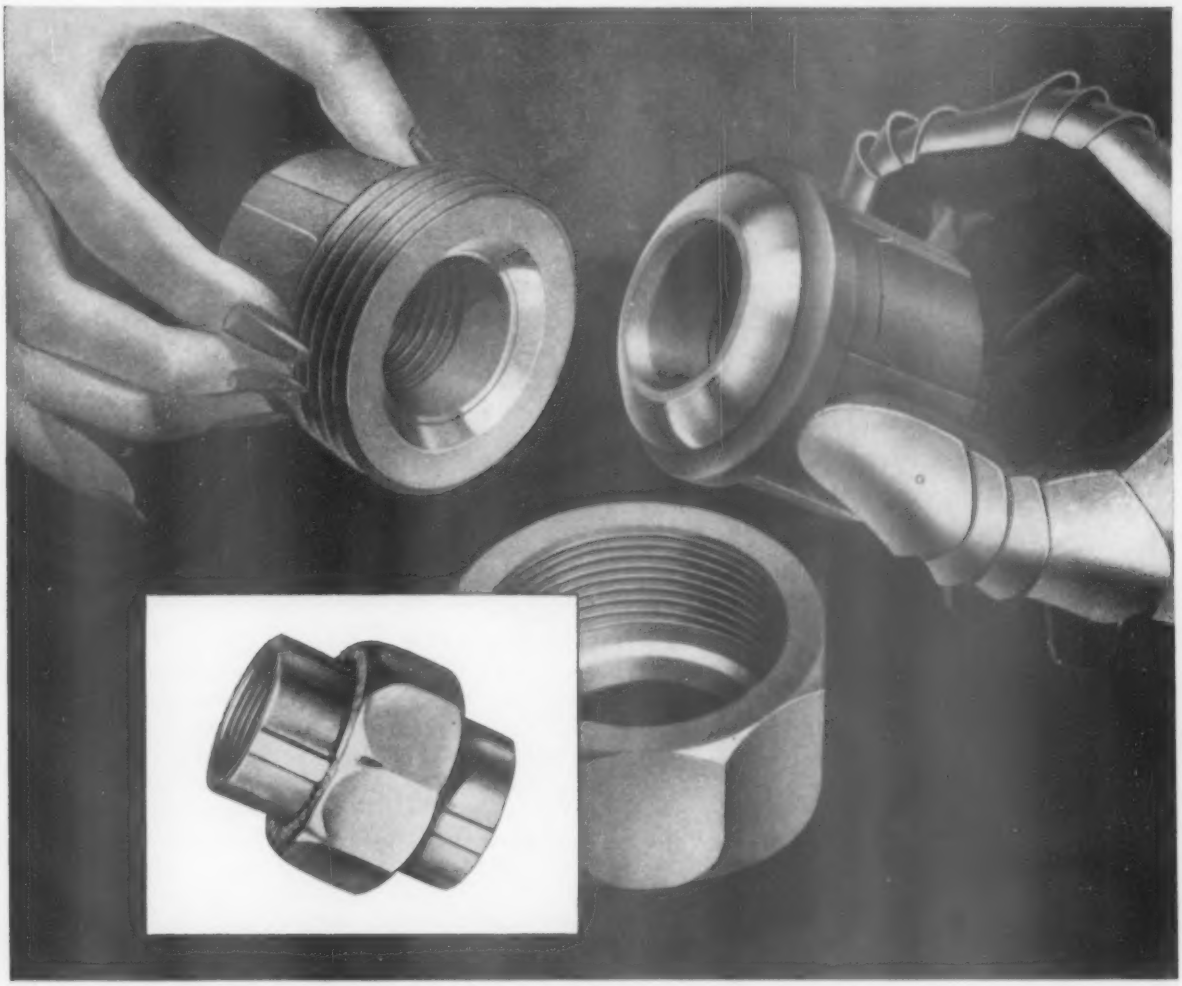
Case histories prove, when Superior engines finally need overhauls, they require few major part replacements . . . down time and maintenance costs are cut to a minimum.

Buy Superior Engines and you make a superior investment! Get all the facts from leading rig manufacturers, or through White Diesel field representatives available in all oil field areas or through White Diesel Engine Division.

WHITE DIESEL ENGINE DIVISION

THE WHITE MOTOR COMPANY • *Plant and General Offices: Springfield, Ohio*

Superior ENGINES ATLAS Imperial DIESEL ENGINES White DIESEL



What a *difference* 150 Brinell makes!

Here's what makes the big difference! *The male seat of the new Rockwood Union #603 is specially treated to make it 150 Brinell harder than the female seat.* That means no galling in make up — longer life for the joint.

This hardness differential gives you superior performance — even under tough working conditions. Each part of the Rockwood Union #603 is interchangeable. Both seats are made of corrosion-resistant AISI molychrome steel, forged in place and bonded-locked under 100,000 and 400,000 pound pressure.

But the difference doesn't stop there! Exclusive "Rockwoodizing" protects entire Union, including threads, against corrosion.

This remarkable Union offers you all these features. You can't ask for anything better.

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Please send me prices and further data on the new Rockwood Union #603. I would also like the name of the nearest Rockwood distributor.

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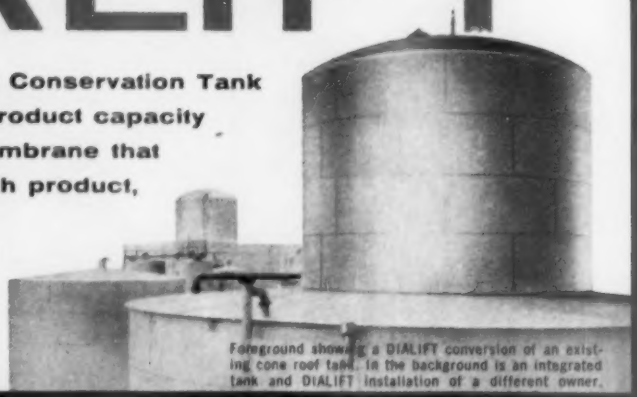
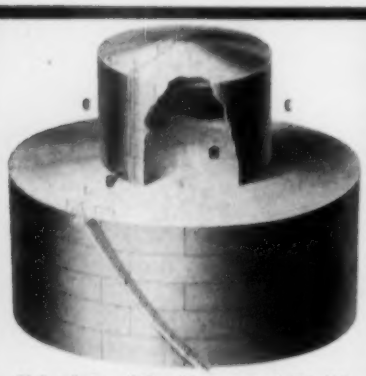
The HAMMOND
DIALIFT

The ONLY membrane type Conservation Tank with full-rated vapor and product capacity AT ALL TIMES, with a membrane that cannot come in contact with product, vapor space that can be isolated for inspection and maintenance without taking product storage tank out of service.



Foreground shows a DIALIFT conversion of an existing cone roof tank. In the background is an integrated tank and DIALIFT installation of a different owner.



Principle of the Hammond Dialift

A— DIALIFT DIAPHRAGM rises and falls to accommodate expanding and contracting vapor.
B— Vapor passes to and from tank and DIALIFT through simple elbow connection.
C—DIALIFT and tank have full-rated capacity.
D—Membrane can't come in contact with product.
E—DIALIFT can be isolated for maintenance and inspection, product tank stays in service.

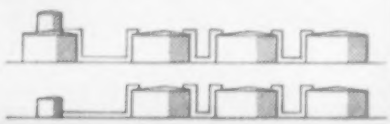
The most efficient and economical vapor conservation system for new or old tanks.

THE HAMMOND DIALIFT consists of a gas-tight Vulcalock membrane attached to the inside periphery of a cylindrical metal housing to become a "breathing" apparatus to accommodate the expanding and contracting vapor as developed in product storage tanks. The DIALIFT can be used as a single conservation unit by being attached to the roof of a product storage tank or as a central "breathing" system by being manifolded to a number of product storage tanks. There are two forms of installation: —Ground type manifolded to a number of tanks to form a conservation system and integrated type whereby the DIALIFT is attached to the roof of a product tank for vapor conservation for one or a number of tanks.

The DIALIFT is completely isolated from the product storage tank. Vapor passes between the tank and DIALIFT through a vaporline connection. It is easy to convert old cone roof tanks to efficient vapor-saving DIALIFT installations by attaching a DIALIFT housing with membrane to the roof of the old tank and connecting the vaporline between the tank and DIALIFT.

New or converted DIALIFT tank, inter-connected with cone-roof tanks, becomes central "breathing" unit.

DIALIFT GROUND UNIT serves as central "breathing" apparatus of multi-tank conservation system.



THE HAMMOND DIALIFT ELIMINATES BREATHING LOSS AND REDUCES FILLING LOSS

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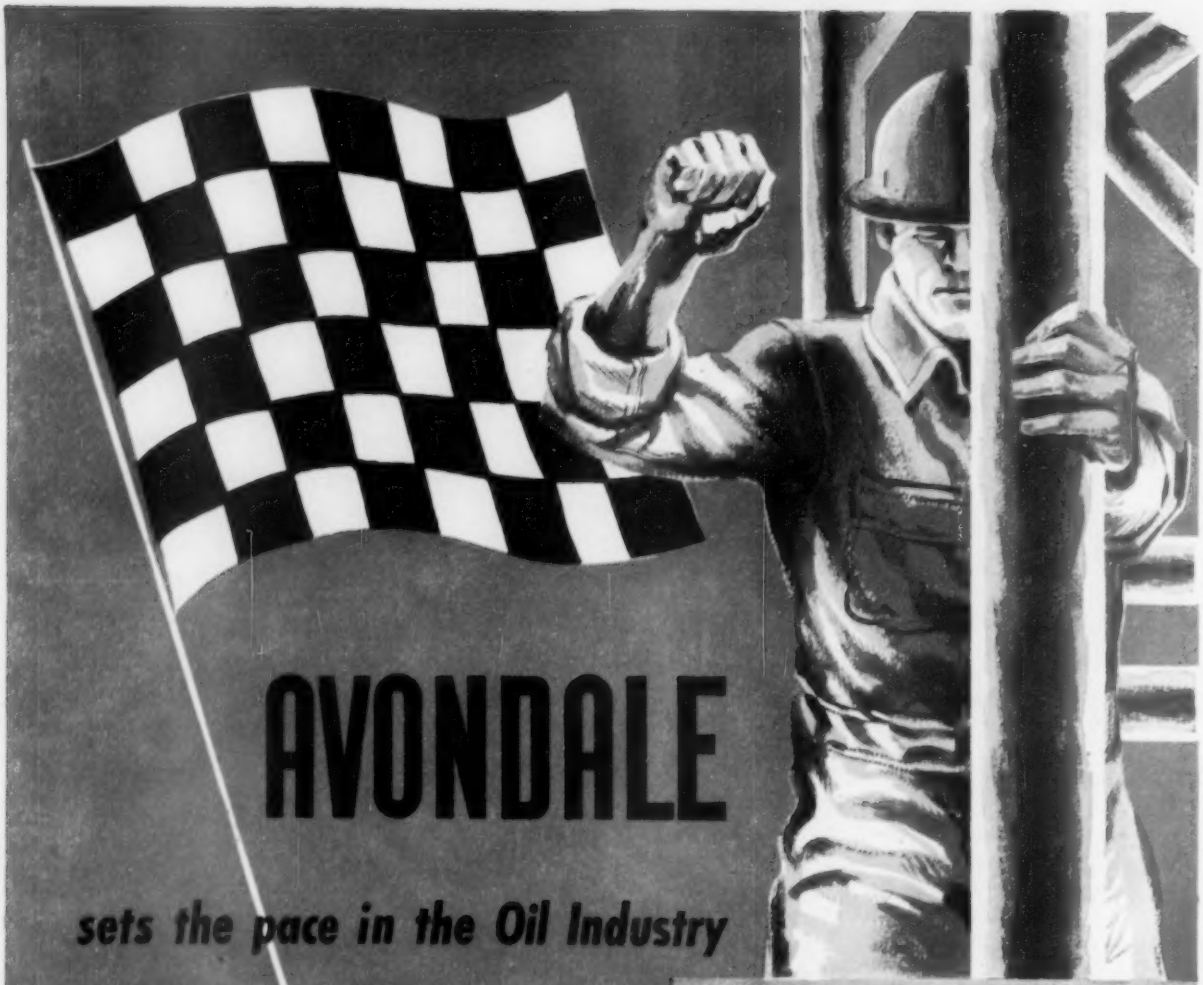

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sets the pace in the Oil Industry

Everywhere you go in the oil country, you'll find "Pace-Setters" built by Avondale—pipe jackets, vessels and barges of all kinds, offshore drilling rigs and platform structures. You'll find successful conversions, too—LSTs and other craft . . . and many, many examples of Avondale's skilled repair jobs. On land, you'll see pace-setting service stations built of Avoncraft porcelain enamel—still another example of Avondale's versatile and complete service to the Oil Industry. For your next construction, repair, or fabrication job, large or small . . . call Avondale.

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AVONDALE MARINE WAYS, INC. CABLE ADDRESS "AVONWAYS"

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"FLAME-TIGHT" CONTACT CHAMBER

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"FULL-CIRCLE" VENTING

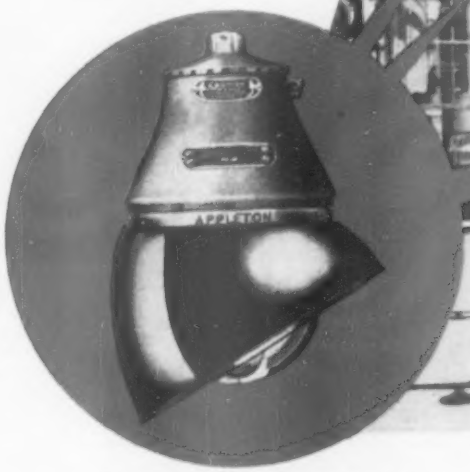
Porous metal interior and specially designed hood dissipate heat evenly and safely . . . keep fixture temperature down, provide longer lamp life.

"INTERCHANGEABLE" UNILET BODY

Standardized diameters at top of Dome Unit Assembly permit interchange with AA-51 fixtures of varying wattages.

plus

conversion to different wattages or relamping in just *58 SECONDS!* . . . with no loss of man-hours or lengthy shut-downs. Send for complete information today!



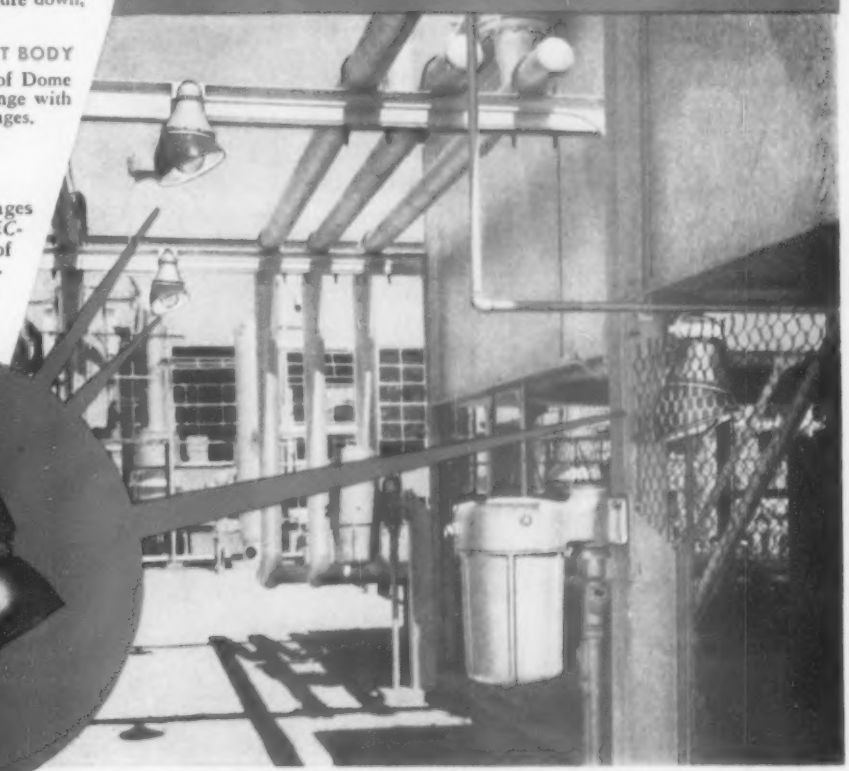
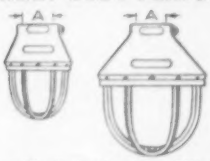


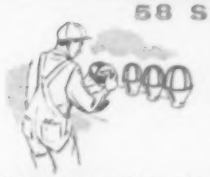
Photo Courtesy Oil and Gas Journal

58 SECOND RELAMPING

APPLETON INTERCHANGEABLE UNILET BODY FEATURE



Note how identical diameters "A" on Dome Assemblies allow quick interchange of fixtures with different wattages.



Series AA-51 stand-by units are ready at an instant's notice for relamping . . . with handles attached in advance.

Only a screw driver is needed to change units . . . and **ONLY 58 SECONDS** to climb ladder, change unit and descend!

Cleaning fixtures, changing burned out lamps can safely be attended to at bench . . . preventing costly shut-downs.

APPLETON ELECTRIC COMPANY
1718 Wellington Avenue, Chicago 13, Illinois

Also Manufacturers of:

Industrial Lights

Automatic Reclitet

Malleable Iron Unilet Fittings

"ST" Series Connectors

Outlet Boxes

Sold Only Through Selected Wholesalers

APPLETON ELECTRIC PRODUCTS

Rely on **APPLETON** *. . . the standard for better wiring*

LORAINS "GO TO SEA" ON OFFSHORE OPERATIONS

Drillers and pipeliners are going to sea more and more. And wherever they go, Lorains go with them, just as they go with drillers and pipeliners on land. The same dependable features and advantages that make Lorains so popular with oil field men, are the reasons they are chosen for these sea-going assignments. Here are two different offshore operations . . . and Lorains are on deck for both of them.

G. B. GLASSCOCK DRILLING CO.

Corpus Christi, Texas

"MR. GUS" is the largest self-contained mobile offshore drilling unit. It is equipped with two pier-mounted Lorains—a 6-ton "TL-10" and a 22½-ton "424." The "424" is shown in this picture. "Mr. Gus" cost a total of $3½-million, is as tall as a 7-story building and can drill in water up to 100 ft. deep. Both Lorains handle pipe and supplies and transfer personnel from crew boats to barge platform. The "424" is used in erection of production platforms and installs piling, too.

SAM CARLINE, INC., *Berwick, La.*

Another offshore job, and this time it's laying 10" concrete coated pipe submerged in the Gulf of Mexico, for Marine Gathering Co. of Houston, Texas. The submerged lines gather oil from offshore wells. Here, two more Lorains selected by Sam Carline, Inc., who specializes in laying submerged pipe, are "on deck." The two Lorain-50 Cranes operate from a 200 ft. long plank roadway along the entire length of this special lay barge and are used to handle pipe sections prior to welding and to feed the welded and coated pipe into the water.

Complete selection in the Lorain line makes it possible for oil men to better fit their needs—on land or offshore, in the field, on the pipelines, or in the refineries—with Lorains. Ask your Thew-Lorain Distributor for facts on the many sizes, types and mountings for lowest cost performance.

THE THEW SHOVEL CO., LORAIN, OHIO

THEW LORAIN®

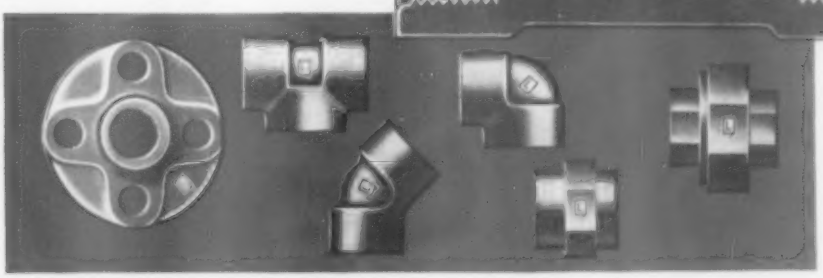
LUNCOR PVC VALVES REPLACE HIGH-ALLOY VALVES

Also Replace Valves Lined With Glass, Porcelain, Stoneware, Hard Rubber At Substantial Savings

LUNCOR is the first all-molded PVC valve designed and engineered by a valve manufacturer. LUNCOR PVC is a strong, rigid type of unplasticized polyvinyl chloride. The valve design has been created to take full advantage of the properties of PVC. LUNCOR PVC can be molded to precise tolerances and is remarkably corrosion-resistant, odorless, tasteless, non-toxic, non-porous, non-contaminating, and weighs only one-sixth as much as metal. The new valve, with its full line of fittings, permits ready installation of complete plastic piping systems.

Every part is made of all molded LUNCOR PVC . . . body, bonnet, disc, stem, and handwheel. Packing is self-lubricating Teflon.

FIG. 2600
125 WP
140°F.



LUNCOR FITTINGS

The complete line of fittings which complements the new LUNCOR Valve includes: caps, couplings, plugs, unions, reducing bushings, flanges, elbows, and tees. LUNCOR Fittings are made of the same high-quality rigid polyvinyl chloride as the Lunkenheimer LUNCOR Valve.

REQUEST LITERATURE FROM YOUR LUNKENHEIMER DISTRIBUTOR OR FROM THE LUNKENHEIMER COMPANY, BOX 360, CINCINNATI 14, OHIO.

LUNKENHEIMER®

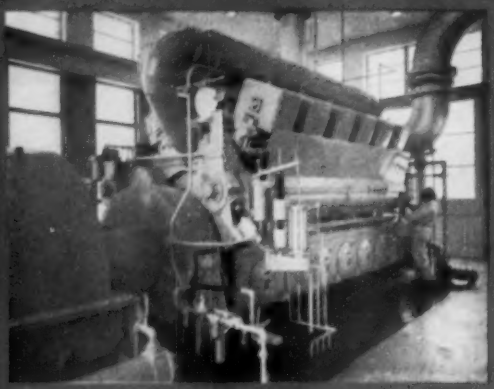
THE ONE *Great* NAME IN VALVES

L-255-16

V-TYPE ENGINES

Nordberg *Supairthermal* V-type engines are built with 10, 12, 14 and 16 cylinders, offering a range up to 5000 hp per engine . . . for Diesel, Duafuel® or Spark-Ignition Gas operation.

(Illustrated is a typical 12-cylinder, 2650 hp *Supairthermal* V-type Diesel engine in pipe line service.)



NORDBERG *Supairthermal*® ENGINES

the logical choice for

PIPE LINE POWER

● On today's modern pipe lines, the trend is toward Nordberg *Supairthermal* engine power. The reasons are simple and sound . . . these compact engines produce *more* power in *less* space—substantially reducing installation and operating costs. What's more—the efficiency of these powerful engines turns low fuel consumption rates into *profit dollars* at the end of the line.

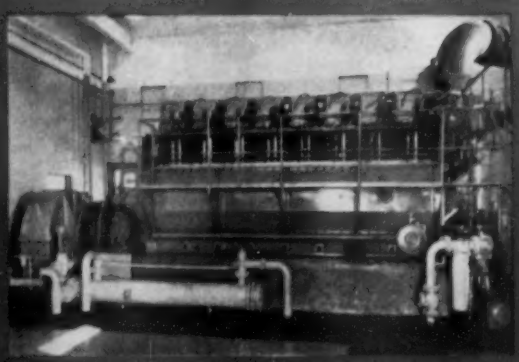
Hundreds of Nordberg engines are daily furnishing continuous, dependable pipe line power in a wide variety of installations . . . from pumping and generating units in permanent trunk line stations, to self-contained portable units for production pumping. Evidence that you will benefit by discussing your power problems with experienced Nordberg engineers.

NORDBERG MFG. CO.
Milwaukee, Wisconsin, U.S.A.

IN-LINE ENGINES

Nordberg *Supairthermal* IN-LINE engines are built in 9" and 13" bore sizes, developing from 535 horsepower upwards . . . for Diesel, Duafuel® or Spark-Ignition Gas operation.

(Illustrated is a typical 8-cylinder, 13" bore *Supairthermal* Spark-Ignition Gas engine operating on a large products pipe line.)



NORDBERG

DIESEL • DUAFUEL® AND SPARK IGNITION GAS ENGINES

© 1955, Nordberg Mfg. Co. O455

Two important factors in catalyst performance are particle density and particle size distribution. Davison controls *both* independently. Thus we provide multiple grades of fluid cracking catalyst and so make it possible for you to select exactly the characteristics required for optimum performance under the special conditions found in your units.

Davison has for many years been the leader in the production of catalysts. The leadership was established and has been maintained because of Davison's ability to produce catalysts to best meet the requirements of individual fluid catalytic cracking units.

For information on Davison catalysts see your Davison Representative or write

Progress Through Chemistry

DAVISON CHEMICAL COMPANY

Division of W. R. Grace & Co.

Baltimore 3, Maryland

Sales Offices: Chicago, Ill.; Houston, Tex.; New York, N. Y.; Baltimore, Md.
In Canada: Davison Chemical Company Ltd., Toronto

Producers of: Catalysts, Inorganic Acids, Superphosphates, Triple Superphosphates, Phosphate Rock, Silica Gels and Silicofluorides. Sole Producers of DAVCO® Granulated Fertilizers.

BEST OF *Everything* IN . . .
PETROLEUM EQUIPMENT & SUPPLIES

20 STORES AND OFFICES IN THE UNITED STATES AND CANADA

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GRAYVILLE, ILL.	DALLAS, TEX.	FORT MORGAN, COLO.	NEWCASTLE, WYO.
OKLAHOMA CITY, OKLA.	HOUSTON, TEX.	MT. PLEASANT, MICH.	NEW YORK, N. Y.
RATLIFF CITY, OKLA.	MIDLAND, TEX.	EAST CHICAGO, IND.	CALGARY, ALTA.
TULSA, OKLA.	ODESSA, TEX.	MORGAN CITY, LA.	EDMONTON, ALTA.

Makes 37,500 ft. of hole

and Tiger Brand Line is still in excellent condition

"It was a lucky day we switched to Tiger Brand Rope," says Jack White, Tool Pusher. "We hit oil on all three wells drilled with this rope."

Tri-State Drilling Co's Rig No. 2 going through a hard strata of limestone near Soso, Mississippi.

Jack R. White, Tool Pusher for the Tri-State Drilling Company near Soso, Mississippi, says, "We've drilled three wells with this Tiger Brand line and we struck oil in all three at a depth of about 12,500 feet. The line is still in *excellent* condition and good for a lot more work.

"We get such good service because we follow the recommendations carefully and 'cut in' the rope at regular intervals, so that the actual points of wear are constantly being moved. What's more, this rig has a new style grooved drum which goes a long way toward prolonging the life of any wire rope."

Tiger Brand Wire Lines come in many types to suit every drilling need. In addition to Rotary and Cable Tool Drilling Lines, there are Sand Lines, Torpedo Lines, Winch Lines, Hoisting Rope and Steel Guy Strand. Next time you buy line, get the kind that saves you money—Tiger Brand. Your nearby distributor has *just the line you need.*

SEE THE UNITED STATES STEEL HOUR. It's a full-hour TV program presented every other week by United States Steel. Consult your local newspaper for time and station.

The Right Wire Rope will do the trick!

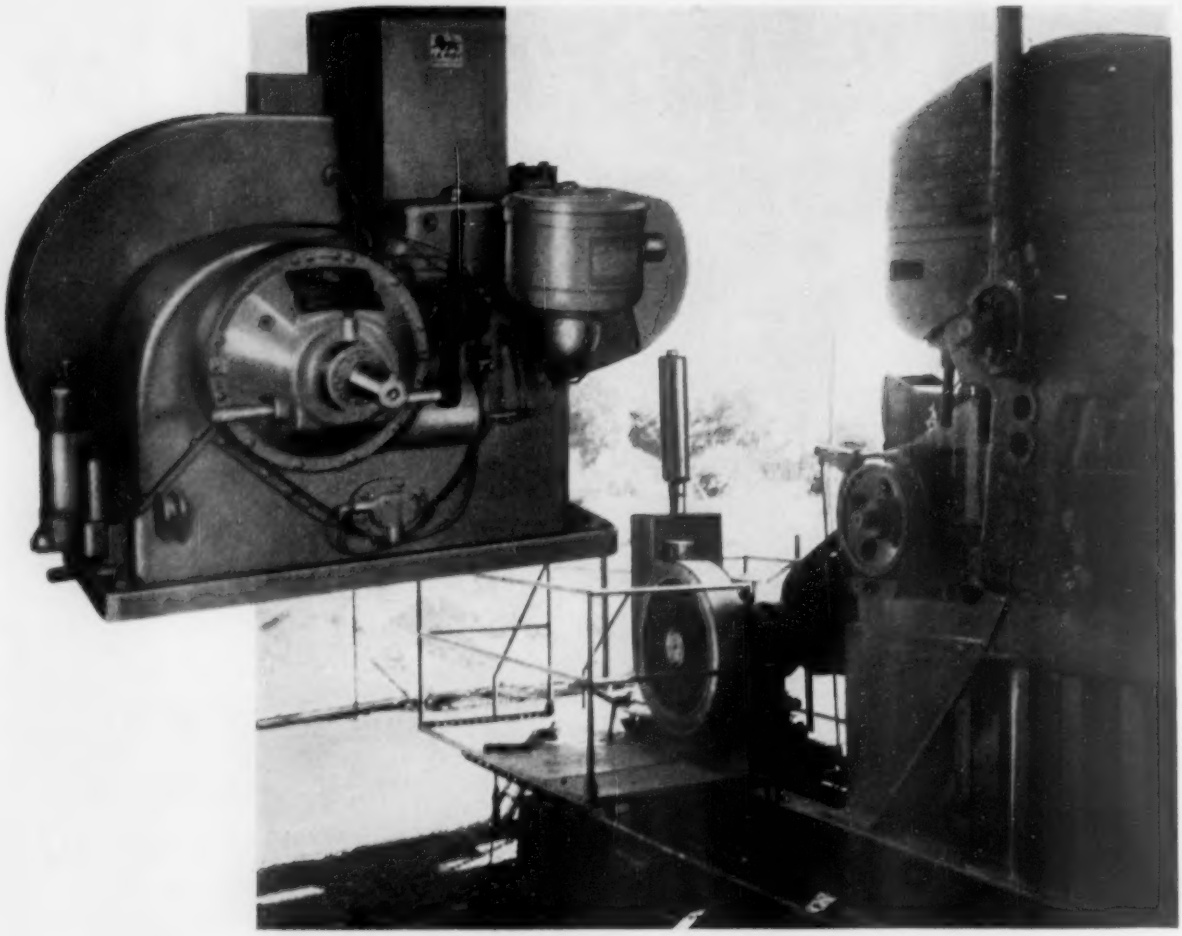
AMERICAN STEEL & WIRE DIVISION, UNITED STATES STEEL, GENERAL OFFICES: CLEVELAND, OHIO
COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

USS AMERICAN TIGER BRAND WIRE ROPE

Excellay Preformed

USS

UNITED STATES STEEL



Total Operating Cost Only 1.2 Mills per Hp Hour

. . . that's why it pays to do your pumping with Le Roi A288's

ACCORDING to the major oil company using this 26.3 max. hp A288, this operating cost is lower than that of any of their other engines.

And here are some of the reasons why the A288 cuts the cost of pumping — why it can run two weeks at a time without inspection.

Patented, "vaporizing-condensing" cooling system seldom needs make-up water. Uniform high temperatures reduce corrosion and sludging.

No superfluous acccessories like grease fittings, conventional-type fan and belts to need attention.

Generous crankcase permits long intervals between oil changes — and no shutdown is required to inspect oil level or add oil.

And performance-wise, you can't beat the A288, or the smaller 14.9 max. hp A114 sister engine, either. One typical installation has more than 47,000 hours on it. Stamina like this is one reason why the A288 is the only pumping engine recommended by a major user for continuous service *unattended for up to two weeks' time.*

Standardize on A288's and watch your pumping costs drop. You can get them from your supply house, or your Le Roi distributor. Or write us for our latest bulletin.

LE ROI *Division of Westinghouse Air Brake Co.*

Milwaukee 14, Wisconsin
District Headquarters: Tulsa, Oklahoma

P-138

Features shock-absorbing BJ Hydraulic Snubber for smooth "floating" action . . . even when handling longest strings!

BYRON JACKSON ANNOUNCES a new line of heavy-duty hooks – the "Hydraplex." This new line – an improvement on the well-known BJ Super Triplex line – contains many new operation and construction features.

One of the features that makes the "Hydraplex" big news is the BJ Hydraulic Snubber. This unique shock absorber eliminates the bouncing action when "jumping" drill pipe stands while coming out of the hole. This cushioning action prevents damage to the tool joints and reduces rig maintenance.

the Big News in Hooks is BJ Hydraplex

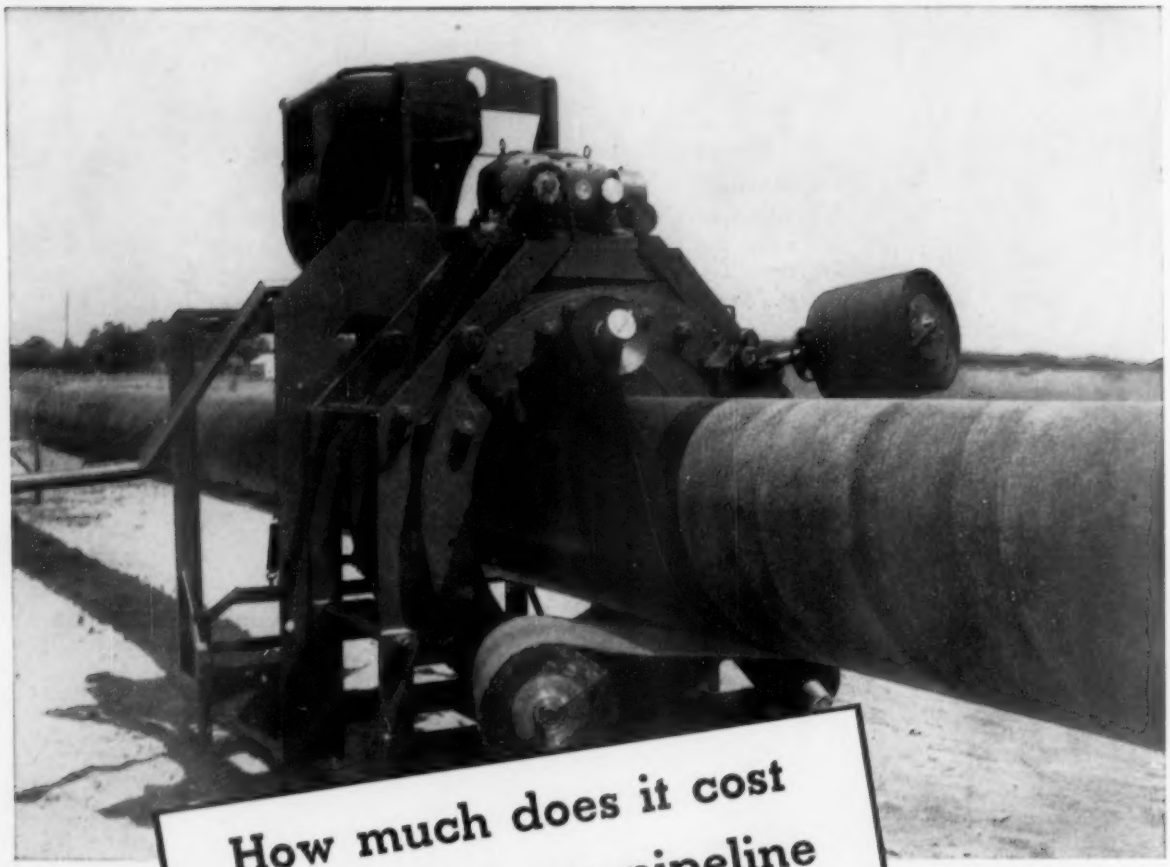
AVAILABLE IN five sizes, with capacity ratings from 100 to 450 tons, BJ "Hydraplex" Hooks answer all present drilling needs and provide for the requirements of the future.

Another outstanding feature of the "Hydraplex" is the time-saving BJ Hook Positioner available as optional equipment. This positioner *automatically* rotates the elevator into the correct position for the derrick man to catch the next stand of pipe while going in the hole.

For more detailed information about the new "Hydraplex," write for Bulletin No. BJO-778.

Byron Jackson
Division of Borg-Warner Corporation
P. O. Box 2017, Terminal Annex, Los Angeles 54, California
Houston • Fort Worth • Denver • New York
Sales engineers in all principal oil fields

BJ
SINCE 1872



How much does it cost to protect your pipeline with Polyken Protective Tape Coatings?

Less than you think . . . a lot less!

In fact, the low applied cost will surprise you. Your engineers have probably told you about the *Polyken* Tapes long-range protection, the controlled and uniform strength, the ease of application. Maybe their enthusiastic reports have made you think your budget wouldn't stand for this quality protection, especially on long line installations.

Take it from us, you *can* afford to use *Polyken* Protective Tape Coatings. This proved protection, applied on your pipeline, is no more expensive than the methods you are now using.

There's only one way to prove this: let us sit down with you and figure out what the applied costs will be for the pipeline you're building. That *specific* installation . . . because you know that in your business there's no other realistic way to figure costs.

Let's talk it over now. Write, wire or phone today. Polyken, *Department OG-K, Division of The Kendall Company, 222 West Adams Street, Chicago 6, Illinois (Randolph 6-4250)*

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CONTROLLED STRENGTH

PROTECTIVE COATINGS

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You'll Find

COMPLETE STOCKS
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CAPABLE ASSISTANCE
PROMPT DELIVERY

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TO GET WHAT YOU WANT
WHERE YOU WANT IT
WHEN YOU NEED IT...
AT REASONABLE
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PARTNERS IN PETROLEUM PROGRESS

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GENERAL OFFICES
TULSA, OKLAHOMA

84 YEARS OF PROGRESS WITH THE OIL INDUSTRY

BE MODERN—BUY WILSON

DEPTH, SIZE or TYPE

Wilson RIGS

MEET YOUR NEED

WHATEVER YOUR REQUIREMENTS . . . THERE'S A WILSON RIG OF THE RIGHT SIZE AND TYPE FOR YOU!

Shown in the illustration is a new Wilson Giant Torcair drilling rig.

● The mast is Wilson's new Giant 126 foot portable drilling mast. It has a rated hook load capacity of 350,000 lbs. with 8 lines strung.

● One unique feature of this mast is that the ease of operation surpasses that of many smaller masts. Its erection is fully hydraulic, the same efficient system that is on the 96 foot Wilson production masts.

● The racking platform automatically folds out into working position at a desired height to accommodate the racking of trebles.

● The rig is a Wilson Giant Double Drum Torcair model powered by two WAKBU Waukesha engines with torque converters. It has an ample power capacity for efficient 8,000 foot work.

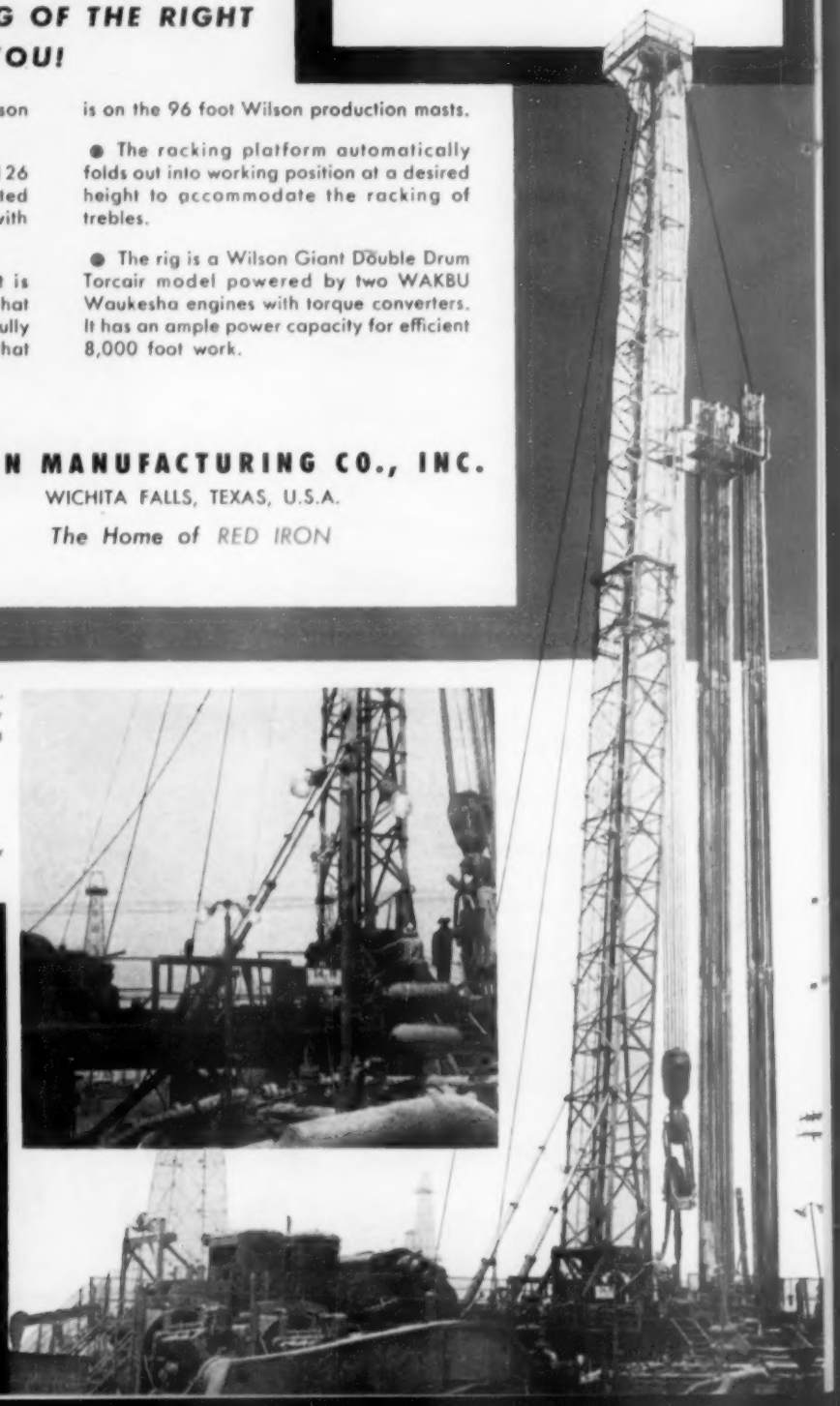
Wilson **WILSON MANUFACTURING CO., INC.**

WICHITA FALLS, TEXAS, U.S.A.

The Home of RED IRON

Photograph at right shows the location of driller's controls, mounted on hinged "Y" base of the mast. Extreme lower left of photo shows hydraulic controls for raising and telescoping mast operations.

Driller is located to have the best position possible for full view of work at all time.



A SENSIBLE APPROACH TO YOUR CONSIDERATION OF MICROWAVE

THIS SERVICE IS AVAILABLE TO YOU WITHOUT CHARGE OR OBLIGATION

More and more companies are turning to microwave for reliable and economical multi-purpose communication and control of widespread facilities. Would a microwave installation increase the efficiency of your operations? You can get the answer to this question by calling for the services of Collins Application Engineering Department. Our engineers will carefully evaluate your need for microwave without charge or obligation. If they find that the nature of your operations is such that microwave is not economically feasible, they'll tell you so. If, as in most cases, you can profit from a microwave installation, they will prepare a recommendation tailored to your requirement . . . again without charge or obligation.

A word about Collins and microwave

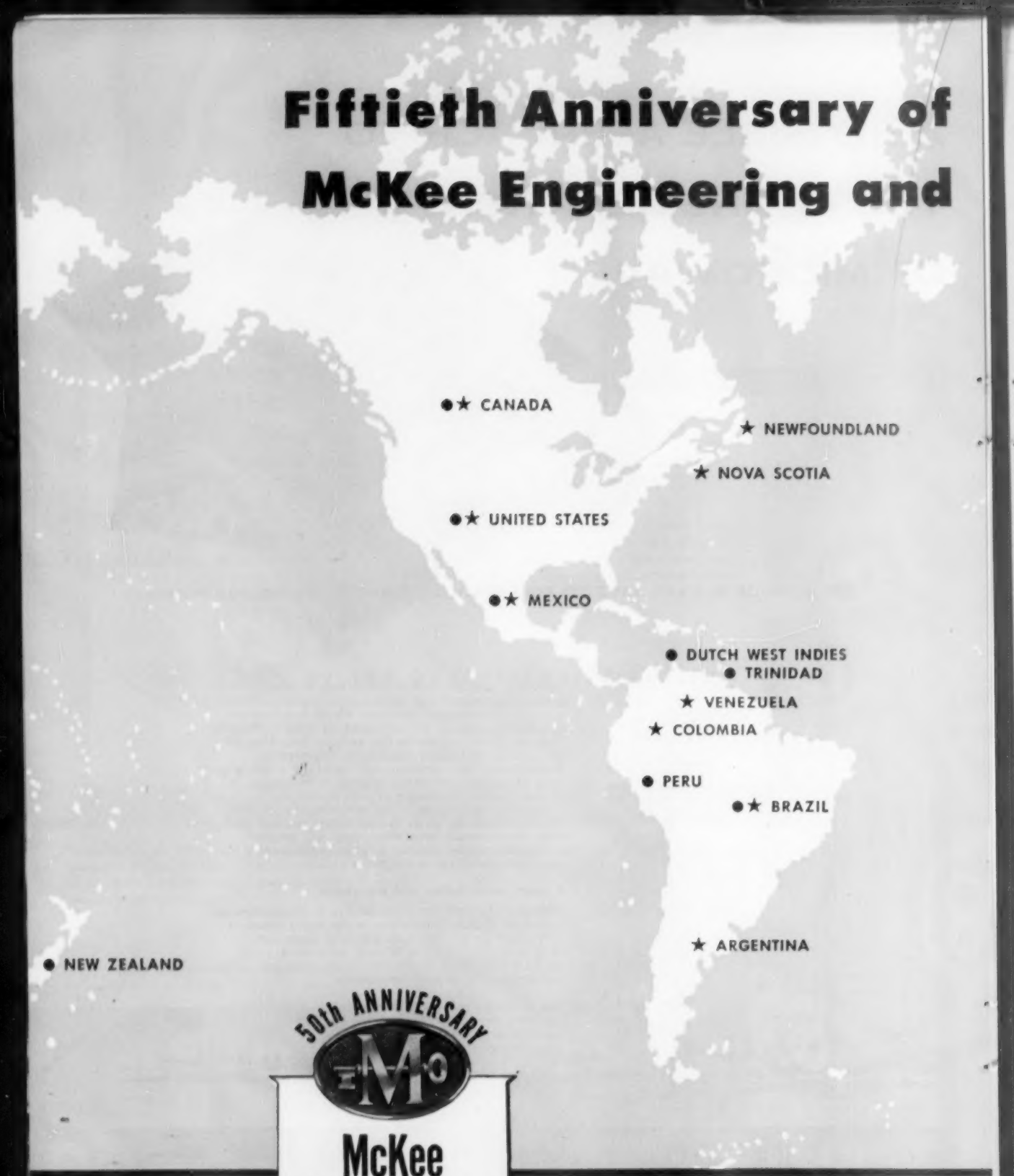
Wherever the need for dependability in communication is critical, Collins Equipment is the world standard of excellence. You can have this same assurance of dependable operation in your microwave facilities by turning to Collins for the planning and engineering of your installation.

Take this sensible approach to the consideration of microwave. Let Collins first evaluate your need, then draw up a proposal for you to study.

COLLINS RADIO COMPANY

COLLINS

Fiftieth Anniversary of McKee Engineering and



50th ANNIVERSARY

McKee Engineering Services

Arthur G. McKee &

HEADQUARTERS
McKee Building
2300 Chester Avenue
Cleveland 1, Ohio

specialized, world-wide Construction Services

IN A HALF-CENTURY of engineering and construction Arthur G. McKee & Company have executed more than 2500 contracts for projects having a combined erected value of more than a billion dollars.

★ **IRON AND STEEL PROJECTS,** including completely integrated plants, blast furnaces, blast furnace components, steel-making plants and ore beneficiating units.

● **PETROLEUM AND CHEMICAL PROJECTS,** including complete refineries, distillation, cracking, reforming, alkylation, polymerization, desulfurization, etc., and chemical and petro-chemical plants in the fields of ammonia, oxygen, sulfur and sulfuric acid.

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372 Bay Street
Toronto, Ont.

POWELL VALVES ... THE COMPLETE QUALITY LINE ... POWELL VALVES

POWELL VALVES FOR PETROLEUM PROCESSING

Fig. 1793 — Flanged End Iron Body Bronze Mounted O.S.& Y. Gate Valve for 125 pounds. 2" to 30", inclusive.

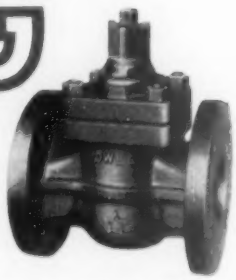


Fig. 2201—Flanged End Semi-Steel Lubricated Plug Valve. 1" to 4", inclusive. Plug Valves also available in Bronze, Carbon Steel, Stainless Steel, Ni-resist and Monel Metal. Sizes up to 12".

Wherever fluids are handled in Petroleum Processing and the making of Petrochemicals, use Powell Valves—and *be sure*. Powell not only offers all kinds of valves—in bronze, iron, steel and a wide selection of corrosion-resisting metals and alloys—for every flow control requirement of the Petroleum Refining Industry, but they have been doing it for years—since 1846. Is it any wonder that leading refiners depend on Powell Valves? Ask your distributor. If none is near you, write—

THE WM. POWELL CO., CINCINNATI 22, OHIO.

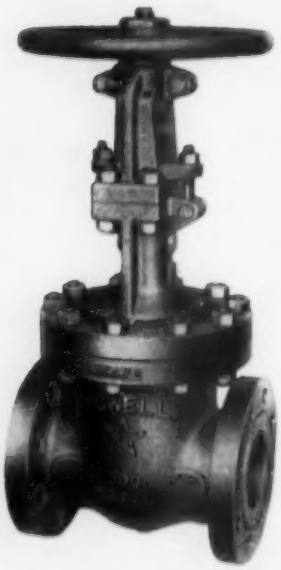


Fig. 3003—Flanged End Steel Gate Valve for 300 pounds. 1" to 30", inclusive. Available for 150 pounds and through 2500 pounds.

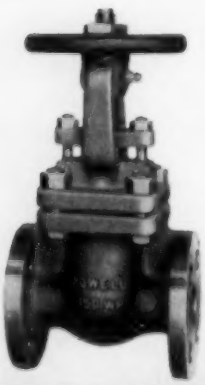


Fig. 2491—Flanged End Stainless Steel O.S.& Y. Gate Valve for 150 pounds. ¼" to 2". 300 and 600 pound valves available.

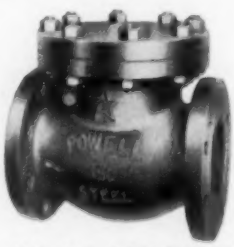
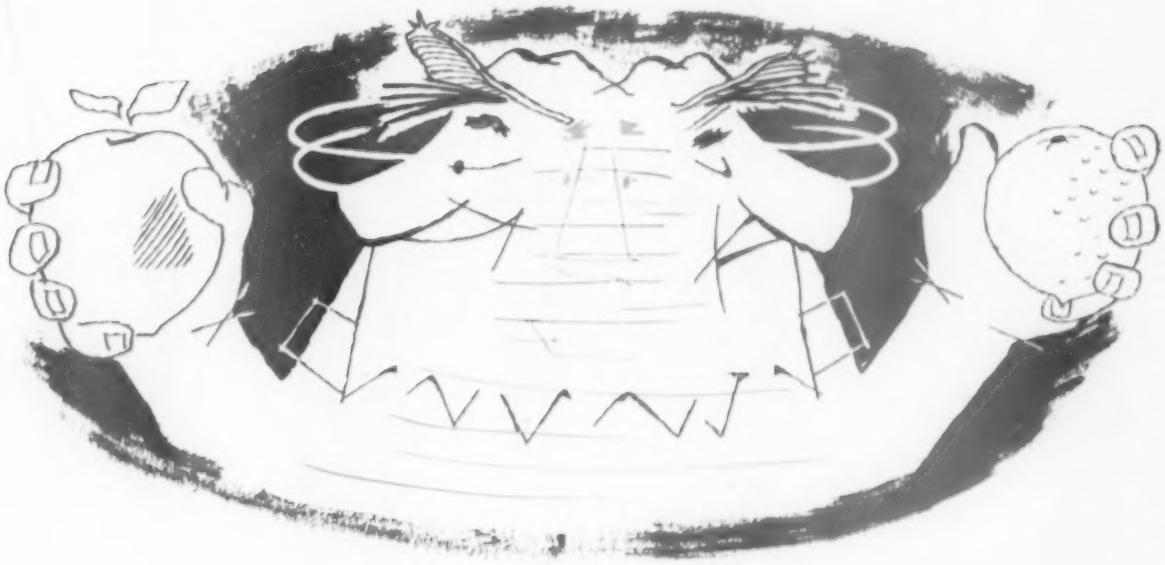


Fig. 1561—Flanged End Steel Swing Check Valve for 150 pounds. ½" to 18", inclusive. Available through 2500 pounds.

Fig. 375 — Screwed End Bronze Union Bonnet Gate Valve for 200 pounds. ¼" to 3", inclusive.

POWELL VALVES ... THE COMPLETE QUALITY LINE ... POWELL VALVES

YOU CAN'T REPLACE A PEACH WITH A LEMON!



says HY WHEELER, the sage of the socket wrench!

Of course, I don't claim *nobody* else makes good bearings—but you're *never in doubt* when you replace a Hyatt with another Hyatt!

Sure, you may save a little dough on "bargain" offbeat bearings—but take it from an oldtimer, *it don't pay in the long run!* Chances are you'll end up havin' to do the whole job over again before long, and with somebody sore at you, too! I figger it's a lot smarter to play safe and *hold out for Hyatts in the blue and yellow box.* When it comes to *quality,*

DISTRIBUTED BY DEALERS EVERYWHERE

there's no substitute for . . .

HYATT ROLLER BEARINGS

STRAIGHT BARREL TAPER

HYATT BEARINGS DIVISION • GENERAL MOTORS CORPORATION • HARRISON, NEW JERSEY

A GENERAL MOTORS PRODUCT GM A UNITED MOTORS LINE

This is Why the Nash is the Most Simple Compressor

It's the Nash!

There are no mechanical complications in a Nash Compressor. A single moving element, a round rotor, with shrouded blades, forming a series of buckets, revolves freely in an elliptical casing containing any low viscosity liquid. This liquid, carried with the rotor, follows the elliptical contour of the casing.

The moving liquid therefore recedes from the rotor buckets at the wide part of the ellipse, permitting the buckets to fill with gas from the stationary Inlet Ports. As the casing narrows, the liquid is forced back into the rotor buckets, compressing the gas, and delivering it through the fixed Outlet Ports.

Nash Compressors produce 75 lbs pressure in a single stage, with capacities to 6 million cu. ft. per day in a single structure. Since compression is secured by an entirely different principle, gas pumping problems difficult with ordinary pumps are often handled easily in a Nash.

Nash simplicity means low maintenance cost, with original pump performance constant over long periods Data on these pumps sent immediately on request

No internal wearing parts.

No valves, pistons, or vanes.

No internal lubrication.

Low maintenance cost.

Saves floor space.

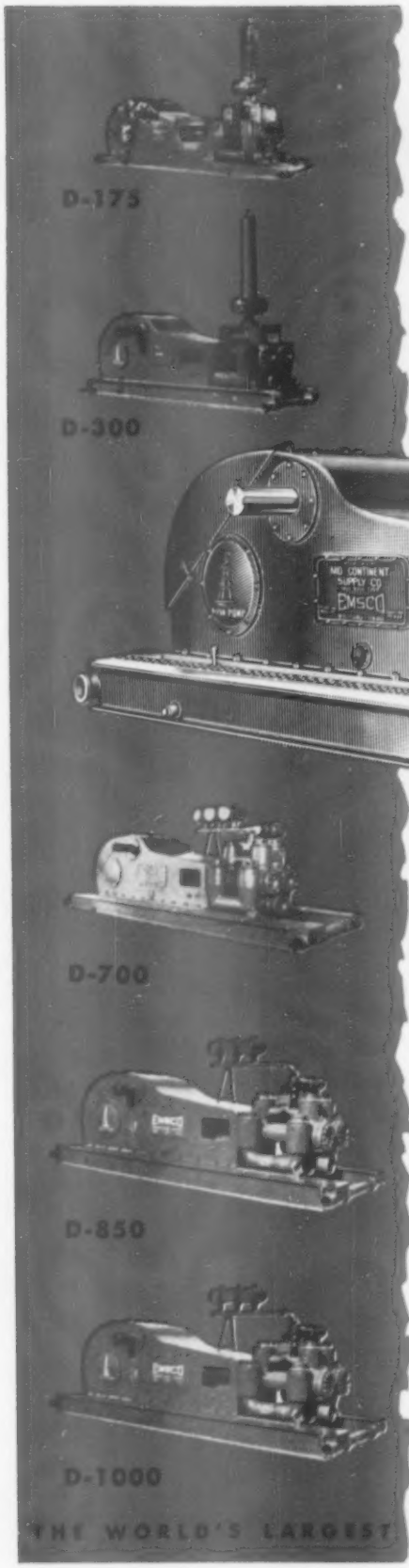
Desired delivery temperature automatically maintained.

Slugs of liquid entering pump will do no harm.

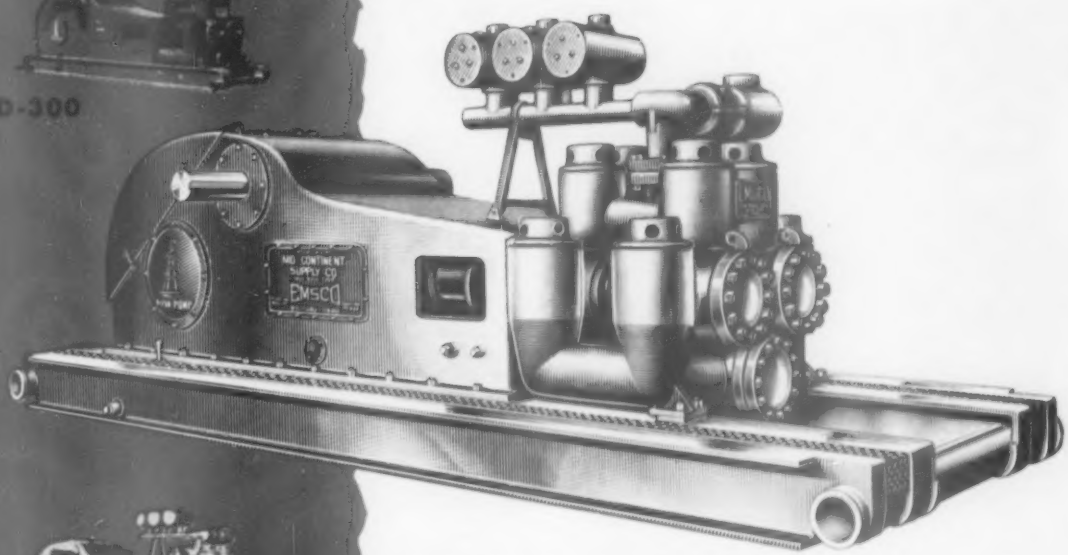
75 pounds in a single stage.

NASH ENGINEERING COMPANY

313 WILSON, SO. NORWALK, CONN.



NOW-EMSCO DA-500
SLUSH PUMP



OFFERS IMPROVED FLUID END FEATURES FOR JET BIT DRILLING

The Emsco DA-500, with its heavy duty fluid end, uses the same big-pump fluid end design as on the D-700 and D-1000 pumps . . . with such features as full flow fluid passages, tentative API valves and seats, heavy cross threaded valve pot covers, exposed liners secured by center-studless cylinder heads, quick break connections for pony and piston rods and fluid pulsation dampeners in addition to all of the quality features which have made Emsco pumps famous for dependable performance and low cost operation.

For complete information on Emsco Pumps for every drilling requirement, contact your nearest Mid-Continent store or representative.

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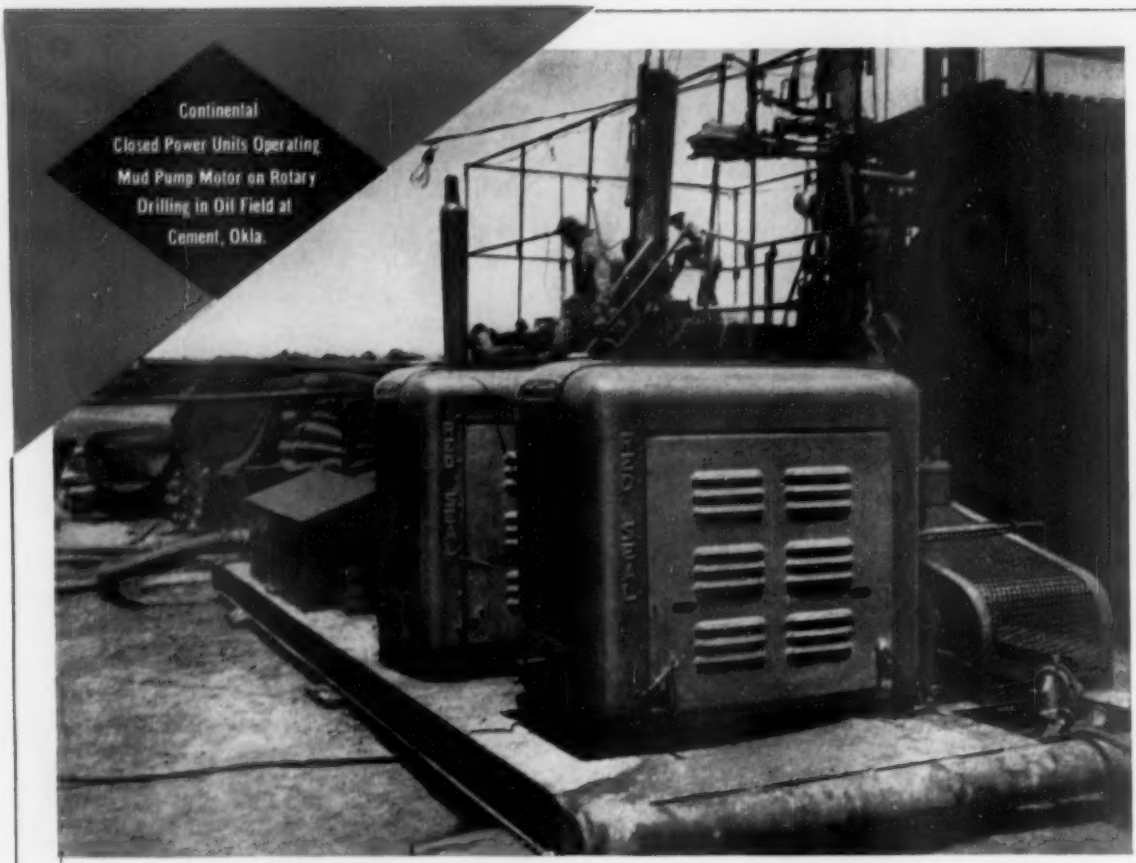
Supply Company
MID-CONTINENT BLDG. • FORT WORTH, TEXAS
EXCLUSIVE EXPORT DISTRIBUTORS
EXPORT DIVISION • 45 ROCKEFELLER PLAZA • NEW YORK, N. Y.

THE WORLD'S LARGEST INDEPENDENT OIL FIELD SUPPLY COMPANY



CONTINENTAL RED SEALS
Run for Years and Years

Throughout the oil fields—in all types of installations—you'll find proof of the stamina that has made Continentals first choice for so many tough jobs. Many of them older than the units shown above are still turning in their full work quota, week in and week out, year in and year out—and, many of them under the least favorable operating conditions. Today's line of Continental Red Seal engines is up-to-the-minute mechanically, as well as broader and more diversified than ever before. There are Red Seal models engineered to the specialized needs of practically every oil field application—models at closely-spaced levels—14 to 240 horsepower—for use on all standard fuels. And, you may be sure of one thing: no other engine built today will give longer service, with less time out, than the Red Seal model engineered and built for your job.

Continental Motors Corporation

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Butyrate pipe cuts installation time

Tenite Butyrate's light weight and easy joining by solvent welding can cut labor installation costs by more than 60%.

Butyrate pipe cuts corrosion failures

Tenite Butyrate resists corrosion by sour crudes, brine and electrolytic soils. This Tenite section from a salt water disposal line is still in good condition after 2 years' service. On the same line, metal pipe used to fail completely in 6 months.

Butyrate pipe cuts paraffin clogging

How much time do you lose in cleaning out paraffin-clogged metal lines? The clean, smooth inner wall of a Tenite pipe offers no toe-holds for paraffin.

Could Tenite Butyrate cut costs for you?

SAVINGS BEGIN the minute you order Tenite Butyrate pipe. Its light weight saves freight, handling and distribution costs. Simple solvent welding with slip-sleeve couplings makes it fast to install. You have no expensive corrosion failure replacements, no periodic cleaning out of accumulated paraffin.

This lightweight pipe is only 1/12th the weight of cement-lined metal pipe. It has good impact resistance and performs well over a wide temperature range.

The petroleum industry has long sought a lightweight, corrosion-resisting pipe that would be strong enough to take the abuse of oil field use. Tenite Butyrate gives you this combination. Years of successful service in all types of fields prove its complete suitability for crude, corrosive water and brine lines. Mail the coupon for more information plus a list of Tenite pipe suppliers. EASTMAN CHEMICAL PRODUCTS, INC., Kingsport, Tennessee, subsidiary of Eastman Kodak Company.

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BUTYRATE
an Eastman plastic

EASTMAN CHEMICAL PRODUCTS, INC.
KINGSPORT, TENNESSEE

Please send me information on TENITE BUTYRATE PIPE and a list of companies manufacturing Tenite pipe and fittings.

NAME .....
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COMPANY .....
STREET .....
CITY ..... STATE .....

OG11-55

for lean oil feed at AMBROSE GASOLINE PLANT...

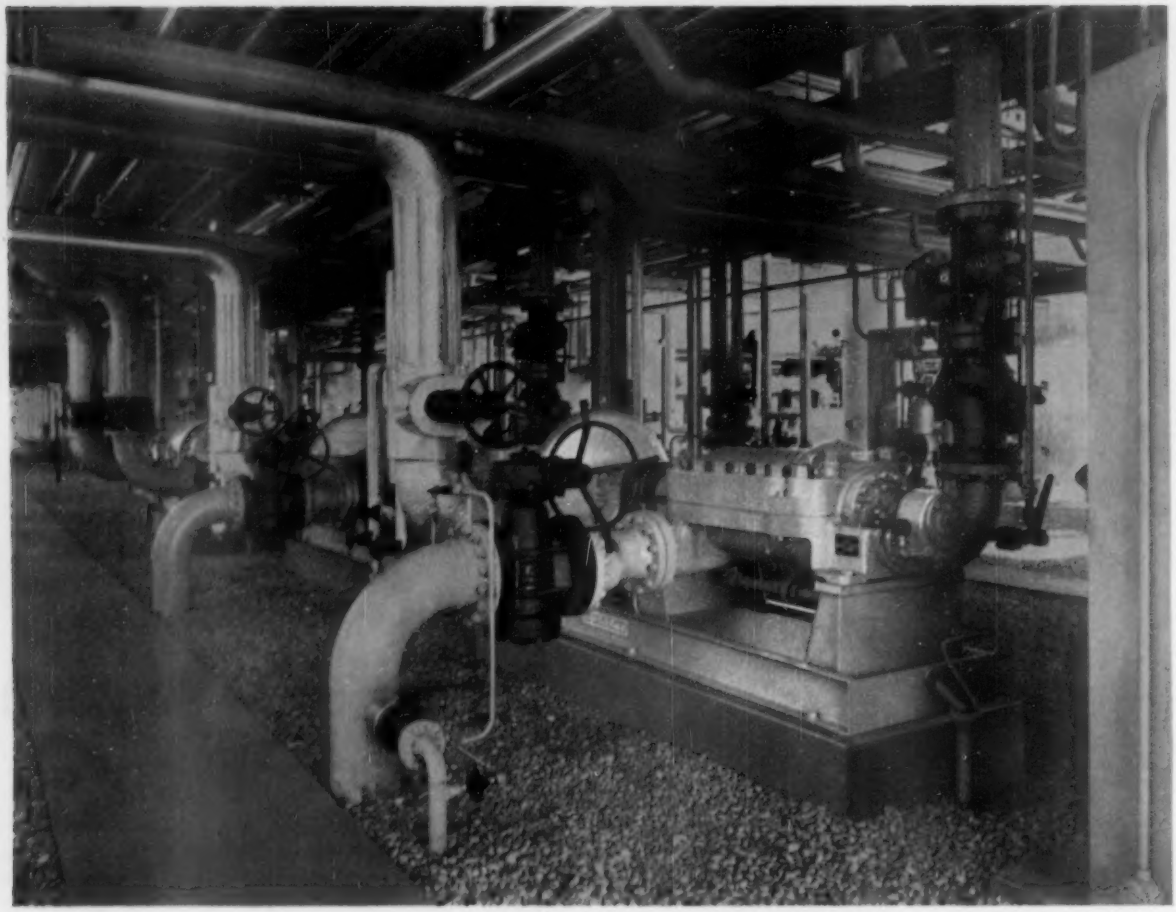

Photo by E. M. Payne

Ingersoll-Rand HMTA Pumps were chosen by Cities Service Oil Company. Three turbine-driven 5-stage pumps, with the I-R Unit-Type rotor assembly, serve the two absorption towers at this Blackwell, Oklahoma plant, designed and built by Hudson Engineering Corp. Present conditions call for 1650 gpm of 0.795 sp. gr. lean oil at 610 psig, but the ultimate designed production rate will require a lean oil pressure of 810 psig. The additional head will be developed by operating the pumps at increased speed. Perfect radial balance at both conditions of operation is assured by the multiple-volute fluid passage design of these HMTA pumps.

Other Ingersoll-Rand pumps at this new plant are on tower reflux, loading, still reflux, boiler feed and water circulation services. Three Ingersoll-Rand 8-cylinder gas engines supply the plant's electric power.

Your liquid moving requirements can be best met from the complete Ingersoll-Rand process pump line. Your nearest I-R office will be glad to study your needs and recommend the right pumps for your job.

Ingersoll-Rand

Cameron Pump Division
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10-11

PUMPS • COMPRESSORS • TURBO-BLOWERS • VACUUM EQUIPMENT • AIR & ELECTRIC TOOLS • GAS & DIESEL ENGINES

The construction a joint venture of Fletcher-Merritt-Raymond under contract to E. B. Badger & Sons Pty. Ltd.

Raymond GOES "DOWN UNDER" FOR CALTEX

AUSTRALIAN OIL REFINING LIMITED a Caltex subsidiary, is one of the latest of the world's leading oil companies to turn to Raymond for specialized heavy construction work. Pictured above is a section of the 2,800 ft. approach trestle which will carry a 54" pipeline and a 15' roadway to the tanker wharf. In this venture Raymond illustrates how cooperation and the coordination of men and methods can accomplish any construction task . . . anywhere.

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Foundations . . . Marine structures and Off-shore Construction . . . Heavy Construction . . . Soil Investigation.

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Anything Less is an Old-Fashioned Truck!

If you don't get all the modern advantages new Chevrolet trucks offer, you stand to lose money on the job today and at trade-in time tomorrow

Look at it this way. The more modern the truck, the more quickly and efficiently it does the job. And if it's loaded with ultra-modern features, you're bound to be farther ahead at trade-in time. Now look at the way Chevrolet fills the bill. Even so-called new trucks are old fashioned without all these Task-Force advantages!

Shortest stroke V8's* of any leading truck—the most modern truck engines money can buy! Their compact, short-stroke design means longer life, because of less friction and wear. Chevrolet's extra-rugged and dependable high-compression valve-in-head Sixes are ultra economical to keep humming. They squeeze more power out of a tankful of gas!

The latest in cab comfort and safety—High-Level ventilation, panoramic windshield, concealed Safety Steps—features that boost driver efficiency!

Most modern chassis features—new suspension, more rigid ladder-type frames, Power Brakes standard equipment on 2-ton jobs!

Work Styling—Here's heavy-duty styling that's matched to the job; modern styling that calls attention to your business! Your Chevrolet dealer has complete details. See him soon. . . . Chevrolet Division of General Motors, Detroit 2, Michigan.

**V8 standard in L.C.F. models, an extra-cost option in all others except Forward-Control models.*

NEW CHEVROLET Task-Force TRUCKS

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To Ship Petroleum Products

With Safety, Convenience, Economy

SPECIFY N.A.T.X.

Specialized knowledge and experience in the handling of petroleum products . . . fleet of modern tank cars . . . continuous and dependable service that keeps 'em rolling day and night to any rail destination in America . . . and an experienced organization of transportation specialists ready and waiting to serve you. Tell us *your* requirements. We'll meet them—*and more!*

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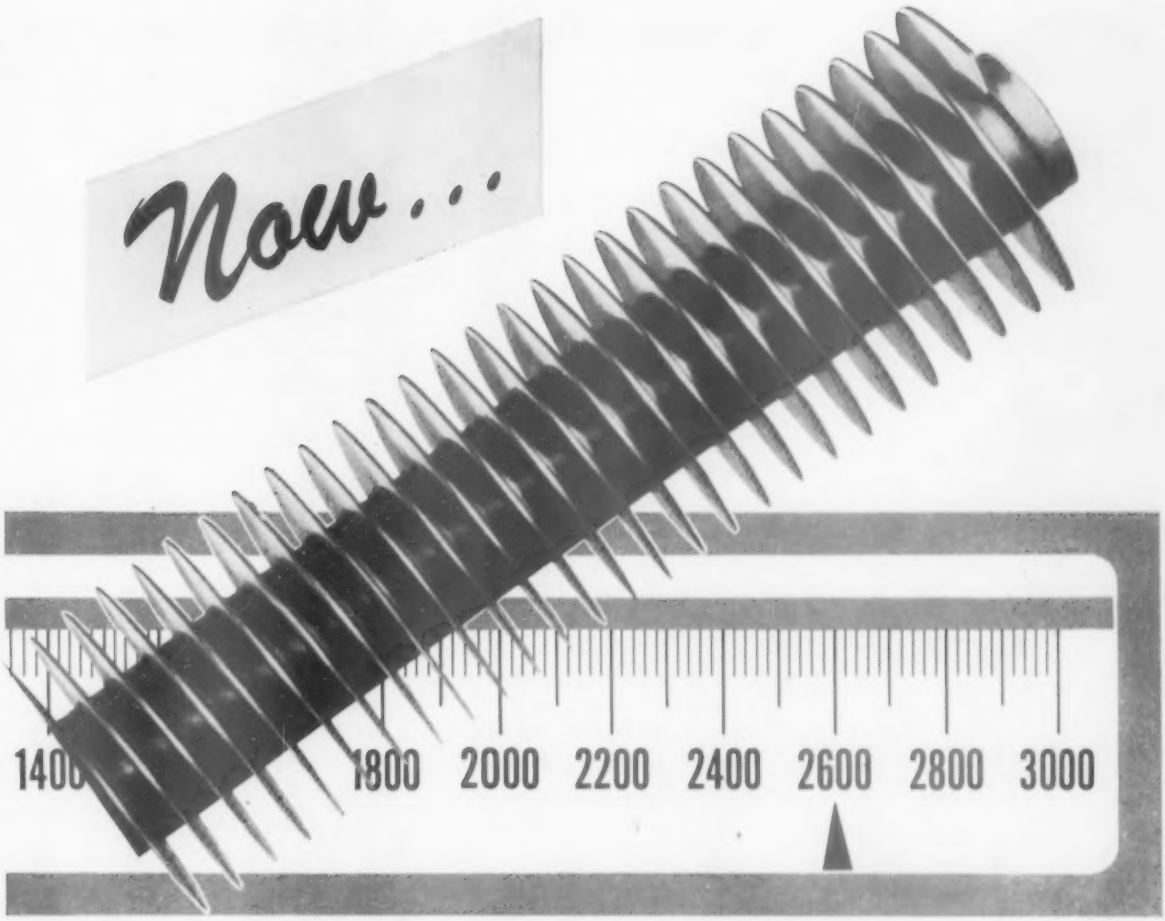


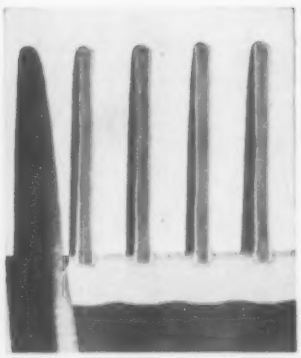


Photo-macrograph of the G-R High-Temperature K-Fin, showing the dual-metal helical fin sealed to the tube by a special brazing alloy. The construction is fully explained in bulletin which will be sent on request.

You can recover heat from gases at extreme temperatures

The G-R High-Temperature K-Fin Heat Transfer Surface now enables you to put to useful work the extremely hot waste gases produced by combustion, by catalytic reactions, or by regeneration of catalysts.

This special G-R finned tube construction can be applied to furnaces or convection heaters with inlet gas temperatures as high as 2600 F, heating fluids such as molten metals to temperatures up to 1500 F.

Write for full information on design and applications.

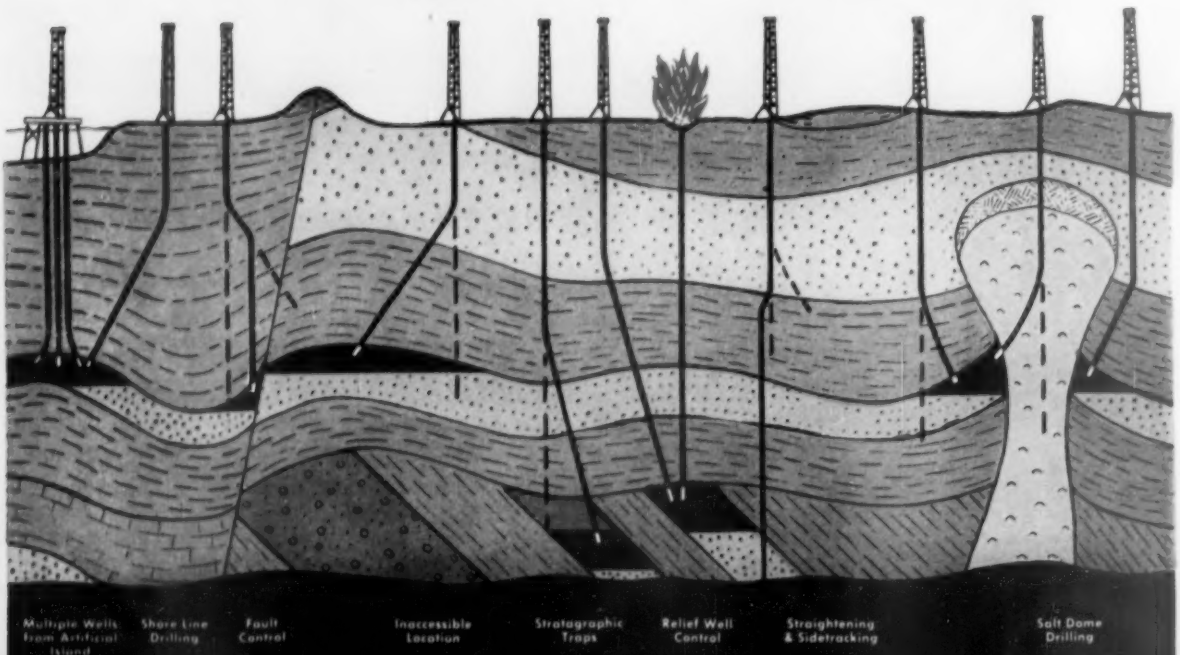
THE GRISCOM-RUSSELL CO.
MASSILLON, OHIO
A SUBSIDIARY OF GENERAL PRECISION EQUIPMENT CORPORATION

G-R
HEAT TRANSFER APPARATUS

High-Temperature K-Fin

These FACTS prove why... service Eastman is Superior in DIRECTIONAL DRILLING, OIL WELL SURVEYING, and SIDETRACKING!

1. Twenty-five years of continuous service which gives you the benefit of our experiences obtained from all the major oil fields throughout the world.
2. Originators of directional drilling and sidetracking services.
3. Pioneers of oil well bore hole surveying.
4. First to offer free engineering consultation service, job planning, and proposals on directional drilling and sidetracking problems.
5. The only service company manufacturing its own complete line of tools and instruments for directional drilling and sub-surface surveying.
6. Constant supervision of all jobs by area superintendents.
7. Only directional drilling company with a full time research and development department devoting time exclusively to directional drilling and surveying problems—the benefits from which accrue to the oil industry in general.



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EASTMAN INTERNATIONAL COMPANY

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THREE NEW MODELS

DH-10
NEW DH-15
DH-20
NEW DH-25
DH-30
NEW DH-35
DH-40
DH-45

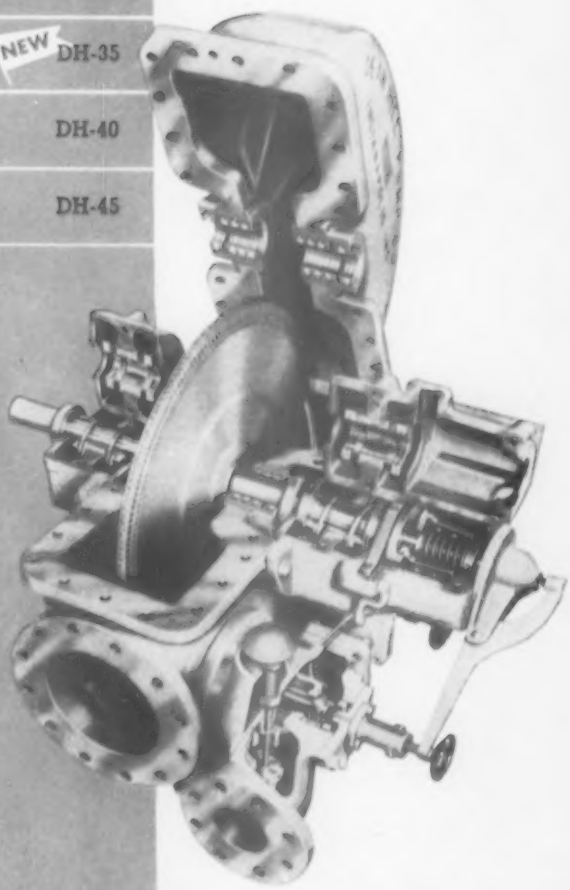
NOW YOU CAN CHOOSE FROM 8 MODELS TO MEET YOUR WORKING REQUIREMENTS

expand DH steam turbine line

The latest in a long series of advancements in the Dean Hill line of horizontal steam turbines is the addition of three new turbines introduced as intermediate models. These new models effect a more gradual increase in power ratings in the horizontal line. The reduced "spread" between ratings in the new 8-model line gives you a better opportunity to match the turbine to the job within a very close margin. Of course, this is always to your advantage in turbine selection.

Because the new models incorporate all the newest improvements made on the other sizes, the Dean Hill horizontal line is one of the most *advanced, complete* lines in the world. With single-stage construction and sleeve bearings, they are specifically designed to operate at medium steam pressures. Low power consumption results in outstanding operational economy of every model in the line.

Write for Catalog No. 500 for details on both vertical and horizontal DH turbines. Information includes cut-a-way illustrations, detailed line drawings, tables, horsepower curves.



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Pump and Turbine Engineers Since 1893
Indianapolis 7, Indiana

Sales Offices In:
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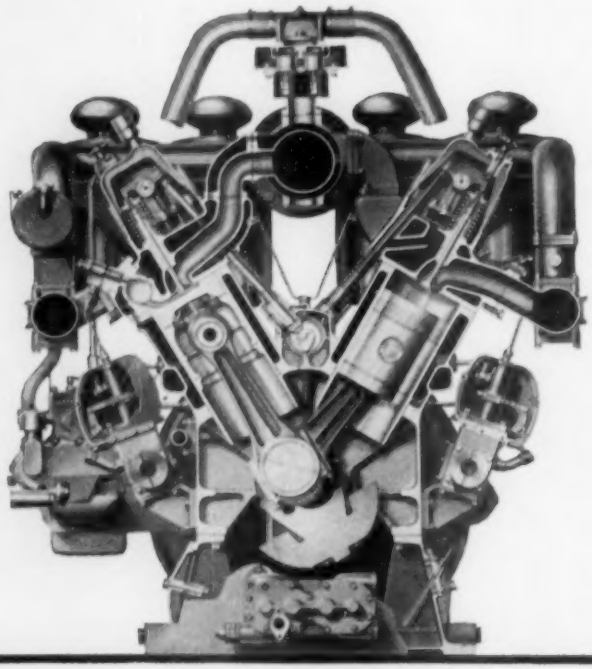
WAUKESHA...one of the

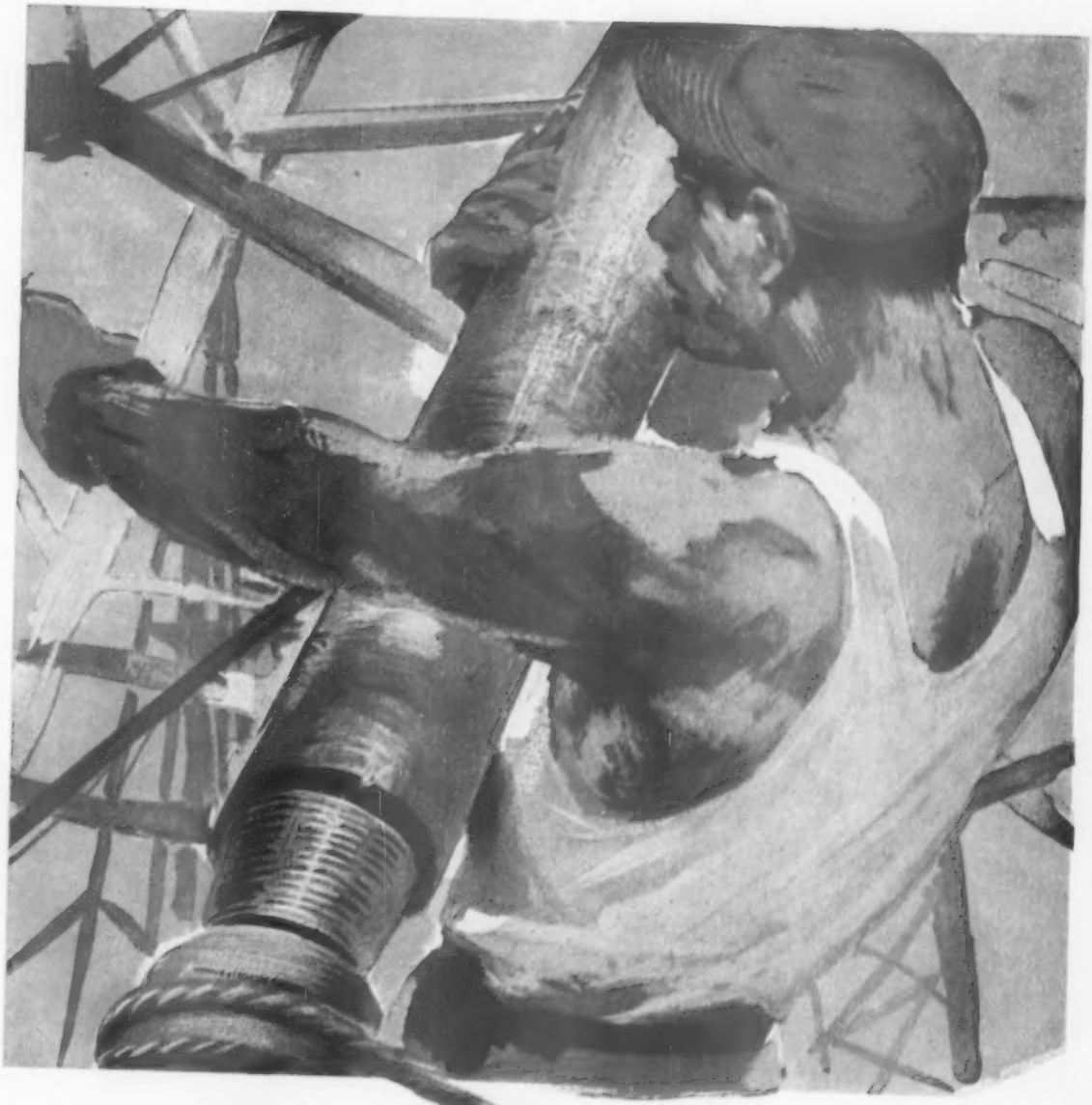
35 engine manufacturers using

Perfect Circle chrome

rings for both original equipment and service

requirements





OIL

Oil is the basic raw material of modern industry. To live without oil would mean that we would have to revert to the age of the mail coach, the Montgolfière, and the sailing ship. Only by means of the revolutionary invention of the Mannesmann pipe has it become possible to win oil from far below the earth's surface. Depths of 15,000 feet and more have been reached with the aid of Mannesmann seamless steel pipes. The stresses which these pipes have to bear, especially the casings, are extremely high. Mannesmann special casings for oil drilling have proved their reliability in oil fields throughout the world. Mannesmann supplies pipes, containers, apparatus and accessories of every type for the extraction, refining, transport and storage of oil and its by-products.

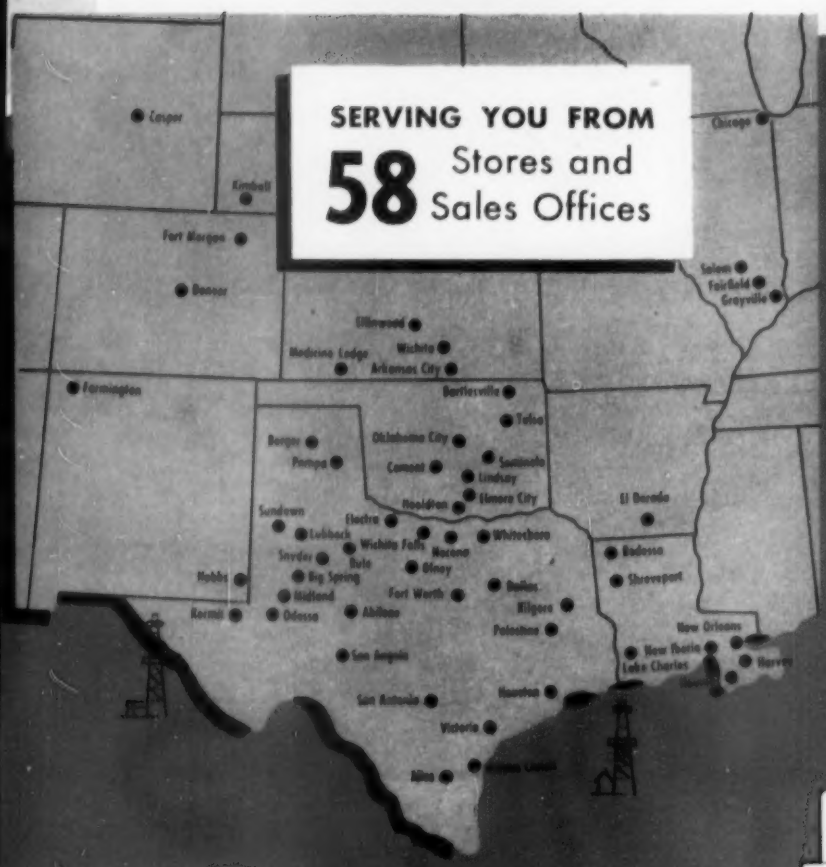
MANNESMANN-EXPORT GMBH DÜSSELDORF

WORLD-WIDE SYSTEM OF REPRESENTATIVES

THERE'S A *Flying "R"* NEAR YOU...

YOUR SUPPLY R STORE

ready to RUSH the finest in production and drilling equipment to YOUR wells and rigs!



To keep pace with your needs in the Oil Country, we at Republic Supply are ever on the alert in establishing new stores near the centers of oil field activity. Our three newest stores are located at . . .

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—MEDICINE LODGE, KANSAS
—PAWHUSKA, OKLAHOMA

These new stores are but a part of a network of sales and service points strategically located to provide fast, efficient service when and where it is needed. A combination of efficient personnel, quality products and expansive coverage assures you of the service you need and deserve. You can always rely on Republic Supply!

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COMPANY

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They Say—

Pipelines for Peace

"I believe that the international pipelines of this continent, and in the Pacific Northwest in particular are worthy of quotation as an example of physical, international, and industrial cooperation in transportation.

"I have no hesitation in saying that it the natural resources of the Middle East were piped to the cities, villages, and homes of the various countries of Europe—east and west—on a business footing with no politics following business and not the reverse, we would see an era of peace come about in Europe which was dependent on mutual industrial needs instead of being beset by fear and intrigue.

"Whilst the goods that are transported by a pipeline company are safely encased within a narrow channel, we believe that the thinking and the studies of the pipeline industry are wide and look far beyond the present economic horizons.

"Pipelining follows in the footsteps of the earlier methods of transportation and shares many truisms in common. Pipelines are built under and over both land and water and can, with good engineering, conquer most barriers. Like the other transportation agencies pipeliners believe that these barriers should be confined to those set up by Mother Nature."

Derrick Humphreys, special assistant, Trans-Mountain Oil Pipeline Co., in address to Pacific Northwest Trade Association, Seattle.

Running Out of Oil?

"There are many things we do not know about petroleum and its accumulation—but we are learning.

"When we add up all the favorable unexplored rocks, the continual stream of new techniques and exploration ideas, a steady increase in recovery, continued conservation, and all the resources that can be translated into petroleum, there is no more reason to say that we are running out of oil now than there was 10, 20, or 30 years ago.

"There would be danger, though, if we were to run out of ideas, techniques, and trained men for finding it. As far as I can see, we have as many and as good new ideas and techniques in sight and coming over the horizon now as ever before. For that reason I see no cause for alarm due to any expected shortage of petroleum supply in the

A Special New Product!

PRODUCED BY THE TENNESSEE CORPORATION, MINERS OF COPPER, ZINC, IRON AND SULFUR.

CUPRIC CHLORIDE

For Removal of Sulfur Compounds in Petroleum Refining.

CONTRACT REQUIREMENTS SOLICITED . . .

We are in a position to supply your needs on annual, semi-annual, or monthly contract basis—also smaller quantities in drop shipment lots.

TYPICAL ANALYSIS

Copper	37.00% Minimum
Moisture	12.00% Maximum
Fe	.04% Maximum
Zn	.01% Maximum
Water Soluble	more than 99.50%
Insoluble as copper oxychloride	less than .50%

FOR 1. Quality Improvement
2. Cost Reduction

CHECK THESE *FEATURES*:

√ HIGHER COPPER CONTENT
√ LOWER MOISTURE
√ FINER PARTICLE SIZE
√ UNIFORMITY
√ AVAILABILITY

CUPRIC CHLORIDE DI-HYDRATE — TC TENNESSEE CORPORATION

Other Tennessee Corporation products, Ferric Sulfate (Ferri-Floc), Copper Sulfate, and Sulfur-Dioxide.

For Samples . . . Make request on your company letterhead.

TENNESSEE TC CORPORATION

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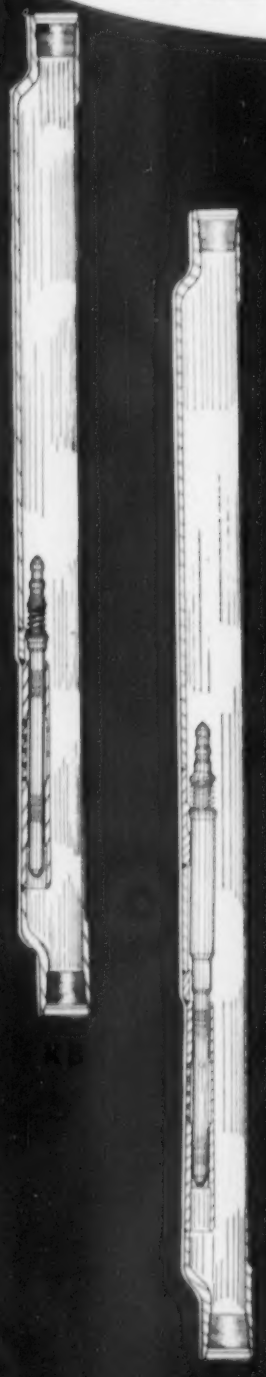
THE *NEW* "SERIES K" RETRIEVABLE VALVES AND MANDRELS



MANDRELS

Ideal for permanent type well completions.

The "K-B" mandrel with "BK" small ported valve in place provides a full open bore through which any wire line operation can be performed.

The "K-C" mandrel accommodates all "BK" valves and the new "CK" large bellows type valves with large ports for intermittent gas injection in deep wells.

VALVES

For every well condition.

Let your Camco engineer help select the valve best suited to your gas lift needs.

Gas Lift CAMCO

THE NEW LOW COST "K" FOR USE IN SMALL CASING SIZES

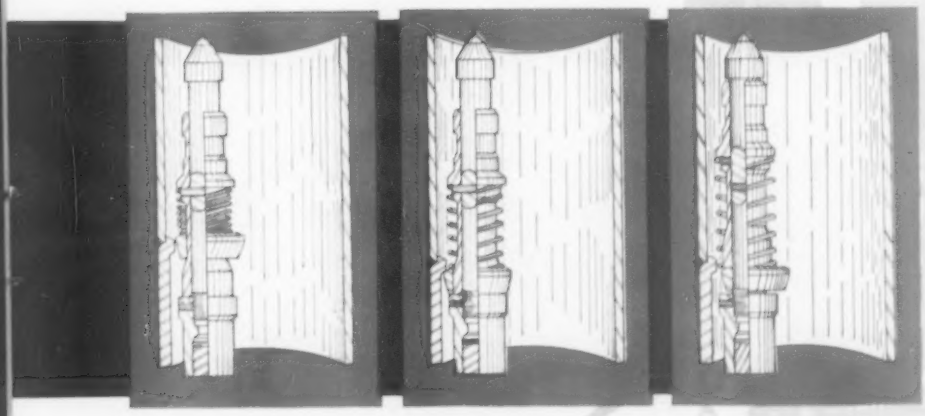
ALL VALVES SELECTIVELY RETRIEVABLE THROUGH THE TUBING STRING!

For any gas lift installation
Regular Retrievable
Dual Retrievable
Permanent type well completion

NEW "K" LATCH— on every "K" valve — positively secures the valve in the mandrel. No sand, cement, or other debris can prevent the operation of this latch.

DUAL COMPLETION EQUIPMENT— Pick the best type of installation for your dual producer. Retrievable valve mandrels are available that will satisfy the requirements for lifting two zones in casing as small as 5½" - 17#.

FOR BAD CASING, mud in the casing annulus, or gas flowing through the casing annulus, gas lift with the modified dual completion mandrel.



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NEW BEDFORD CORDAGE
FOR QUALITY PERFORMANCE
Hitch onto a Star!
★ ★ ★ Top performers, every one . . . an all-star group.
It is with justifiable pride that Continental presents the outstanding products of its associate manufacturers . . . equipment of proved performance that is complemented by dependable Continental service.
THE CONTINENTAL SUPPLY COMPANY
General Offices: DALLAS, TEXAS
Representatives in All Principal Oil Fields of the World
YOUNGSTOWN TUBULAR GOODS
NYB & P RUBBER PRODUCTS
CONTINENTAL
Serving the Oil and Gas Industries
The Petroleum Industry — Since 1859 Helping Make America Great

forseeable future in the United States —certainly none that an increase in incentive will not cure."

Dr. A. I. Levorsen, consulting geologist, Tulsa, in an address before the I.P.A.A. in St. Louis.

Likes New Style

Dear Sir:

A short note of thanks for your new format "In the News" as well as your "Technology-Operation." The group of various subtitles of "In the News" makes it easier to pick out the type of reading matter one is placing a priority of interest.

Being a geologist I am most interested in "Exploration" but I make a quick check of other categories in a hasty manner.

Maury M. Travis
U. S. Geological Survey
Casper, Wyo.

Giveaway Cry a Phony

"Why is it that some nations have been extremely successful in building a petroleum industry while others are content to sit on dormant resources that could make them rich?

"My answer is that we have fostered a political system unique in the world that has brought out the best in all of us . . . And the foundation of it all has been freedom . . .

"Many nations have adopted a philosophy contrary to ours. They say the mineral resources belong to the state for all the people. Therefore, they must be developed by the people, which means by the government . . . a philosophy of life repugnant to most Americans.

"I often think of the millions of acres of public land west of the Allegheny Mountains that was developed by an infant nation dedicated to freedom under the principles laid down by the Constitution. Do those who prate of "giveaways" believe that the people west of the original thirteen states should be tenants of a federal bureaucracy? Do they believe we should never have passed the Homestead Act or the Mining Law of 1876? Yet that is the logical implication of the criticism of this administration for continuing our historic policy of developing the public domain through private initiative. The slogan "giveaway" is a political phony intended for the gullible.

"They characterized passage of the Tidelands Bill as a gigantic "giveaway," but look at the record. Since Congress opened up the outer Continental Shelf along the Gulf Coast for petroleum development leasing, the federal Government has obtained $260 millions in

*ROLOCHECK OIL WELL METERS

assure greater accuracy and less maintenance

IN MEASURING CRUDE OIL OR SALT WATER

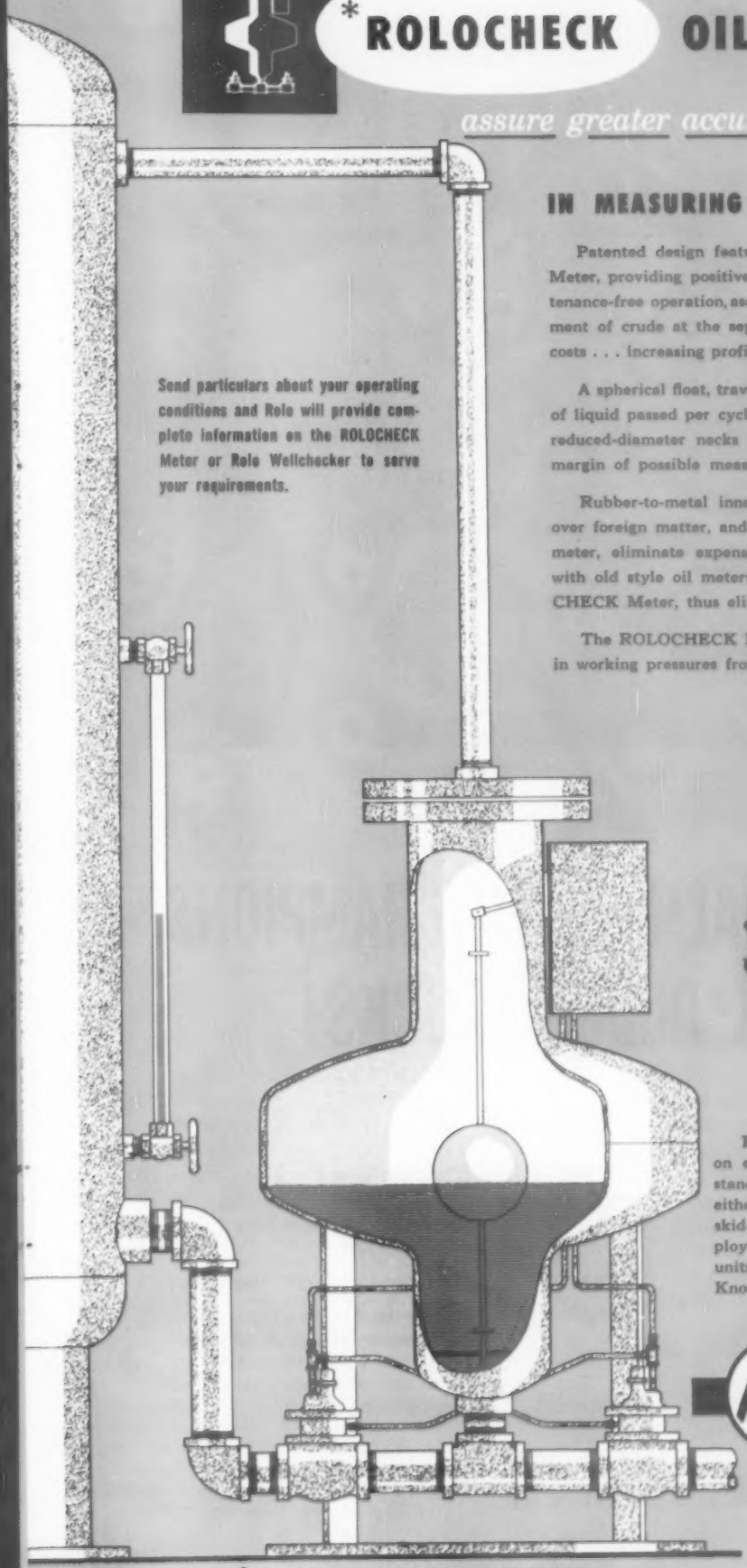
Patented design features of the simplified ROLOCHECK Oil Well Meter, providing positive dumps, positive liquid-level control and maintenance-free operation, assure greater dependability of automatic measurement of crude at the separator on the lease . . . reducing measurement costs . . . increasing profits.

A spherical float, traveling between positive stops, controls the volume of liquid passed per cycle. The liquid level control points are located in reduced-diameter necks at the upper and lower levels, minimizing the margin of possible measurement error in each dump.

Rubber-to-metal inner valves in the dump valves, which will seat over foreign matter, and the lack of close-clearance moving parts in the meter, eliminate expensive maintenance problems usually encountered with old style oil meters. Also, free gas cannot pass through a ROLOCHECK Meter, thus eliminating another source of maintenance worries.

The ROLOCHECK Meter has a zero minimum rate, and is available in working pressures from 150 to 2000 psi and capacities to 4000 BPD.

Send particulars about your operating conditions and Rolo will provide complete information on the ROLOCHECK Meter or Rolo Wellchecker to serve your requirements.



ROLOCHECK Meters are available for installation on existing separators or treaters, and are also now standard equipment on complete Rolo Wellcheckers, either skid- or trailer-mounted. Shown above is a skid-mounted Wellchecker, Type 4-1H-3006-24, employing a ROLOCHECK Oil Meter. These compact units are also available with Automatic Free-Water Knockout.

CRUDE OIL METERING SPECIALISTS

ROLO MANUFACTURING COMPANY

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* TRADEMARK PATENTS ISSUED AND PENDING

WINNER in the tractor tandem-axle trailer event, James S. Jackson (left) of Pilot Freight Carriers, Inc., Winston-Salem, N. C., drove a Dodge 3½-ton V-8 tractor. Driver James E. Tucker (at right) of Charlotte, N. C., representing the Great Southern Trucking Company, also piloted a Dodge to take second place honors in the straight truck event.

AGAIN—NATIONAL ROADEO CHAMPIONS WIN WITH DODGE TRUCKS!

Washington, D. C., Oct. 16, 1955—In the 1955 ATA National Truck Roadeo, 55 state champions competed for the title of the nation's best driver in straight truck, tractor single-axle trailer and tractor tandem-axle trailer events.

Each contestant was required to put his truck through a series of the most grueling tests of driving skill ever devised. These included the Offset Alley Test, as well as Serpentine, Alley Dock, Straight Line and Stop Line Tests. And every contestant was free to drive any make of truck he desired.

The prize-winning achievements of Mr. Jackson and Mr. Tucker speak for themselves. These national champions chose Dodge for its unexcelled maneuverability and performance. It paid off well for them. It can pay off for *you*, too—through savings in time, effort and dollars on your hauling job! Why not look into it with your Dodge truck dealer soon?

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DODGE *Job-Rated* **TRUCKS** WITH THE *FORWARD* LOOK

bonuses, and will receive one-sixth royalty on the oil produced, plus 52 per cent corporate income tax on the net income of those who are successful. Isn't that infinitely better than having the federal Government, as owner of the land, do the drilling and operating as some foreign governments are doing currently?"

Felix Edgar Wormser, assistant secretary for mining resources, Department of Interior, in address at San Francisco.

Trade Fair Boost

Dear Sir:

I wish to take this opportunity to extend the department's sincere appreciation for the contribution you have made to the President's International Trade Fair Program.

The President, when he initiated the program, stated that he had three major objectives in mind through participation in International Trade Fairs—the creation of greater prestige for the U. S., an increased understanding of the United States abroad, and the development of a higher level of exchange of goods and services between our country and foreign countries. We know your publications have been and will be of positive assistance in achieving each of these objectives.

Our trade missions have made extensive use of the reference material so generously provided by the publishers of this country in trade promotion conferences. By the end of 1955, more than 50,000 businessmen throughout the free world will have had an opportunity to see and use the information contained in these libraries. It is anticipated that even more interested users will be reached next year.

You may take pride in the contribution you made in making the President's program so successful. Thank you again for your continuing cooperation with our International Trade Fair Program.

Loring K. Macy
U. S. Department of Commerce
Washington, D. C.

Gas Flow Already Slower

"The impact of the ill conceived interpretation of the Supreme Court in the Phillips case was a paralyzing blow . . . The corrosion that will result has not as yet been fully felt, not only by the consuming public, but by the producers themselves.

". . . New commitments of natural gas to 11 large interstate carriers are falling off sharply. In 1952 the new gas reserves committed to these lines came to 5.3 trillion cubic feet. In 1953 it was 6.4 trillion cubic feet. In 1954 —the first year that the shadows of

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VICTAULIC COUPLINGS

Styles 77, 77-D for standard applications. Simple, fast to install—sturdy and reliable. Sizes ¾" to 30". Style 75 Light-Weight Couplings for light duty applications. Sizes 2", 3", 4". Additional styles for cast iron, plastic and other pipes. Sizes through 60".

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SO SAYS OWNER, Frank C. Heckman, Excavating and Trenching Contractor of Santa Fe, New Mexico. His Cleveland is here shown digging trench for the installation of sewer, water and gas lines in a new building project in Santa Fe. Each house requires a total of about 300 feet of trench, all 20 inches wide but varying in depth down to 4 feet.

Heckman does all the trenching for this construction company which erects about 200 buildings yearly in Santa Fe. In addition he does many scattered trenching jobs throughout the Santa Fe area, much of it for utility companies.

He's sold on his Cleveland's speed and maneuverability for digging short runs of trench profitably and on its rugged dependability for turning out high daily production on pipeline and similar big jobs.

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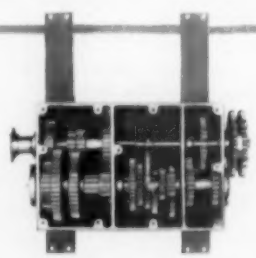

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CLEVELAND

government control fell across the industry — the new commitments were only 2.3 trillion cubic feet. That was just slightly more than ⅓ of the 1953 figure.

"As was pointed out, these 11 lines moved approximately 4 trillion cubic feet in interstate commerce. It is obvious that to do this, they had to draw on their reserve bank accounts of gas. Now they face gradual liquidation of these accounts, unless they enter exploration and production with their own capital; and they are not likely to do that—not as long as they themselves would have to labor under all the uncertainties of cost plus controls.

"The number of gas well completions is on the decline. During the first 8 months of 1955, over-all drilling is up approximately 5 per cent over that for the same period last year. The completions of oil wells are up 6 per cent. The completions of gas wells are on the down grade, running 12 per cent behind last year. Here is concrete evidence of an encroaching paralysis."

W. M. Vaughey, in presidential address before the I.P.A.A. in St. Louis.

Spell It Out

"Petroleum has meant progress . . . Let's look at that word . . . in relation to the petroleum industry.

"P—production.
"R—refining.
"O—oil transportation.
"G—geology and geophysics.
"R—research.
"E—enterprise.
"S—sales.
"S—service."

Robert E. Wilson, chairman of Standard Oil Co. (Ind.), in address before Evansville, Ind., Kiwanis Club.

CALENDAR OF EVENTS

NOVEMBER

27-29 New Mexico Oil and Gas Association, Albuquerque, N. Mex.
27-30 American Institute of Chemical Engineers, annual meeting, Statler Hotel, Detroit.

DECEMBER

1-3 Interstate Oil Compact Commission, La Fonda Hotel, Santa Fe, N. M.
1-3 American Chemical Society, 11th southwest meeting, Shamrock Hotel, Houston.
2 Natural Gasoline Association of America, Panhandle-Plains meeting, Herring Hotel, Amarillo, Tex.
3 National Oil Scouts and Landmen's Association, annual meeting of board of directors, Adolphus Hotel, Dallas.
8-9 Oil Industry Information Committee

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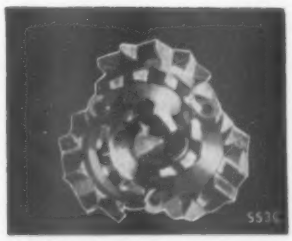
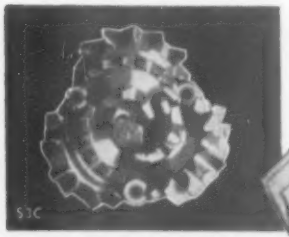
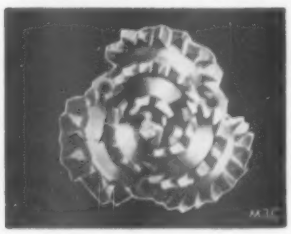
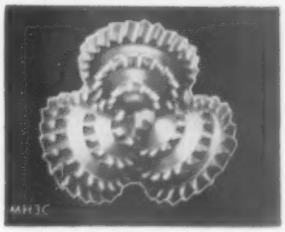
GLOBE 3-CUTTER ROCK BIT

REGULAR and JET TYPE









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The rapidly growing popularity of the Globe "3-Cutter" is no accident. Instead, it is a "hard boiled" dollars and cents evaluation based on PERFORMANCE that has resulted in lower cost, more economical oil well drilling.

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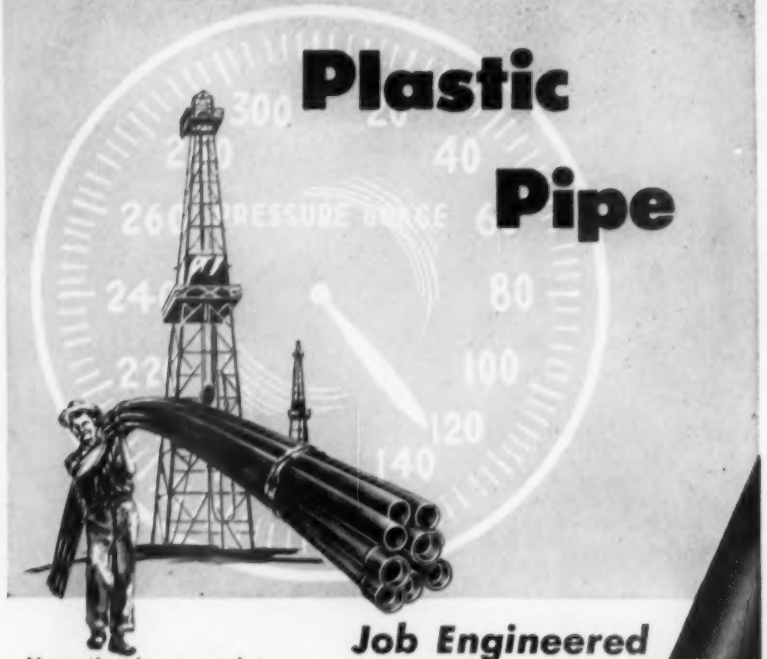

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You can count on "Pressure-Rated" Pipe . . . Guaranteed and manufactured to the rigid specifications that have made Southwestern the Quality Leader in the Plastic Pipe Field. And as for Safety . . . Southwestern "Pressure-Rated" Pipe is engineered with 5 to 1 Safety Factor.

Southwestern "Pressure-Rated" Pipe is available in 50, 75, 100, 125 or 150 pound pressure ratings. Call, write or wire today for complete information.

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SAFETY FACTOR
WALL THICKNESS
Regardless of pressure rating every pipe is manufactured to a strict 5 to 1 Safety Ratio

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PLASTIC PIPE CO.
A Division of Texas Vitrified Pipe Co.
MINERAL WELLS, TEXAS PH. 2050

meeting, Biltmore Hotel, New York City.

1956

JANUARY

9-13 Society of Automotive Engineers, annual meeting, Sheraton-Cadillac and Statler Hotels, Detroit, Mich.

16-18 Pipe Line Contractors Association, eighth annual convention, Boca Raton Hotel and Club, Boca Raton, Fla.

FEBRUARY

15-17 National Association of Corrosion Engineers Short Course for Pipeliners, Mayo Hotel, Tulsa.

19-23 American Institute of Mining and Metallurgical Engineers, annual meeting, Hotel Statler, New York City.

24 Natural Gasoline Association of America, Permian Basin meeting, Lincoln Hotel, Odessa, Tex.

26-29 American Institute of Chemical Engineers, Statler Hotel, Los Angeles.

27-29 American Association of Petroleum Geologists, Rocky Mountain Section, Auditorium, Denver.

MARCH

7-9 American Petroleum Institute, Division of Production, Southern District meeting, Plaza Hotel, San Antonio, Tex.

12-16 National Association of Corrosion Engineers, annual convention, Statler Hotel, New York City.

19-21 Western Petroleum Refiners Association, annual meeting, Plaza Hotel, San Antonio, Tex.

21-23 American Petroleum Institute, Division of Production, Southwestern District meeting, Texas Hotel, Fort Worth.

APRIL

3-5 Annaul Corrosion Control Short Course, University of Oklahoma Extension Study Center, Norman, Okla.

4-6 American Petroleum Institute, Division of Production, Mid-Continent District meeting, Broadview Hotel, Wichita, Kans.

11-13 Natural Gasoline Association of America, Texas Hotel, Fort Worth.

14-18 Petroleum Equipment Suppliers Association, annual meeting, Boca Raton Hotel & Club, Boca Raton, Fla.

15-17 Texas Independent Producers and Royalty Owners Association, Statler Hilton Hotel, Dallas.

17-19 Southwestern Gas Measurement Short Course, University of Oklahoma, Norman, Okla.

18-20 American Petroleum Institute, Division of Prduction, Rocky Mountain District meeting, Cosmopolitan Hotel, Denver.

18-20 National Petroleum Association, semiannual meeting, Cleveland Hotel, Cleveland, Ohio.

19-21 Gas Appliances Manufacturers Association, annual meeting, The Greenbriar Hotel, White Sulphur Springs, W. Va.

23-25 Southern Gas Association convention, Dallas.

23-26 American Association of Petroleum Geologists and Society of Economic Paleontologists, annual meeting, Conrad Hotel, Chicago.

25-27 American Petroleum Institute, Division of Production, Eastern District meeting, Deshler-Hilton Hotel, Columbus, Ohio.

30

May 1 Independent Petroleum Association of America, semiannual meeting, Statler Hotel, Los Angeles.

30

May 4 American Petroleum Institute, Safety and Fire Prevention midyear meeting, Warwick Hotel, Philadelphia.

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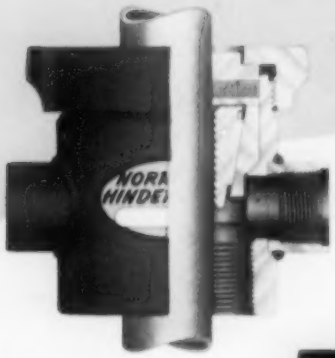
Take time to compare...



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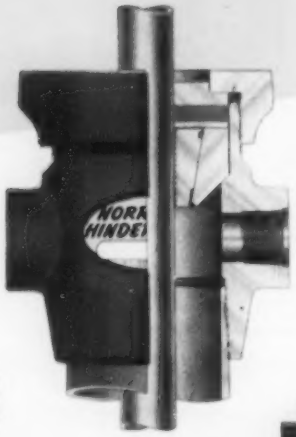
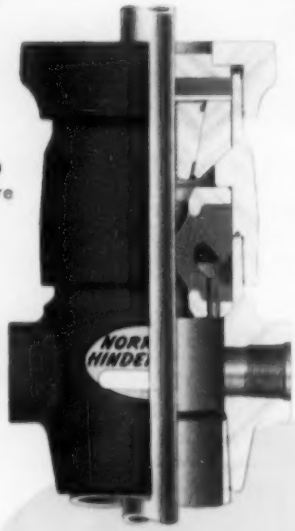
TUBING HEAD
2000# Test Pressure
1000# C.W.P.



HW 2-in-1
TUBING HEAD
4000# Test Pressure
2000# C.W.P.

HW 4-in-1
TUBING HEAD
4000# Test Pressure
2000# C.W.P.



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The OIL AND GAS JOURNAL

TULSA, OKLAHOMA

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JOURNALLY SPEAKING . . .

That Oil War

WELL, it looks as though we really are going to have that oil war with Canada we forecast on this page a couple of weeks ago.

Patriots are springing to arms (or at at least to typewriters) to defend the fair name of the United States oil industry against the brash insults and defamatory claims hurled by the upstart Canadian oil men.

Those Canadians, you will recall, figuratively fired on Fort Sumter by insinuating that Drake didn't drill the first commercial oil well near Titusville, Pa., in 1859 and start the oil industry. They allow as how the oil industry was started by one of their boys, named Williams or something like that, in Ontario along about 1857 or '58, or maybe it was '59 or '60.

We have had a whole raft of letters (four by actual count) from indignant U.S. oil men insisting that no stone be left unhurled to insure that Drake's escutcheon remain unsullied as the legitimate granddaddy of the business.

Quite naturally, most of this indignation originates in Titusville where the boosters for the local Drake Well Memorial Park take a jaundiced view of the possibilities of a rival tourist attraction being established at the site of this spurious "first" oil well on the alien north shore of Lake Erie.

However, the curator of that venerable shrine is not among the hotheads demanding immediate redress by bloodshed. With a self-restraint highly commendable in these days of international tension, he issued a press release couched in firm but polite language restating the position of the Drakeites. So conciliatory is the tone of this *aide memoire*, in fact, that it heretically admits that neither the Drake well nor the Williams well can claim to be the first on the continent, since there were producing oil wells in Ohio in 1814, in Kentucky in 1829, and in Pennsylvania in 1846.

"For Edwin L. Drake," says this document, "it can be proved that he fathered the oil industry because (1) his well was the first deliberately 'drilled' for oil and successfully completed; (2) he demonstrated in a practical manner—through drilling—how oil could be gotten in commercial quantities; and (3) as a result of his success, hundreds of men immediately rushed to drill for oil."

If this leads to war, it may become an international fracas, with Peru getting into the act. We have a letter from a Texan detailing a lengthy and highly interesting account of how a concessionaire from the King of Spain produced oil near Talara, Peru, for many years in the early 1600's, boiling the crude down to asphalt to calk the seams of His Hispanic Majesty's treasure galleons. The concession is now owned by International Petroleum Co.

This thing is getting serious. We hear rumblings that Burma is preparing to claim that it had an oil industry as far back as the birth of Christ. But that's not the worst of it. With Egypt and Israel already at swords' points, there may be no hope for peace if these two ancient rivals advance their claims to mothering petroleum's antiquity. Didn't the infant Moses float to the safety of Pharoah's daughter in a basket lined with petroleum pitch? And what do you think Noah used to calk the Ark?

Before this becomes an international *cause celebre*, we suggest an attempt at conciliation, and hereby extend our good offices, as the diplomats say.

Perhaps, by carefully weasel-worded phrases and judiciously hedging adjectives, an uneasy truce can be forged around an agreement that oil was commercially produced and profitably utilized in many places so long ago that the memory of man runneth not to the contrary; that the oil industry as such almost got a start at many of these times and places but didn't flourish and spread; and that the modern oil industry as we know it today can be traced back without a break to the hullabaloo that broke loose around Titusville the day after Drake did whatever it was he did.

Also, and this really may be more important, that oil as an industry owes its existence to the North American spirit of free enterprise. (Stress that word "North" as a gesture of international amity and hemispheric solidarity.)

—*Henry D. Ralph.*

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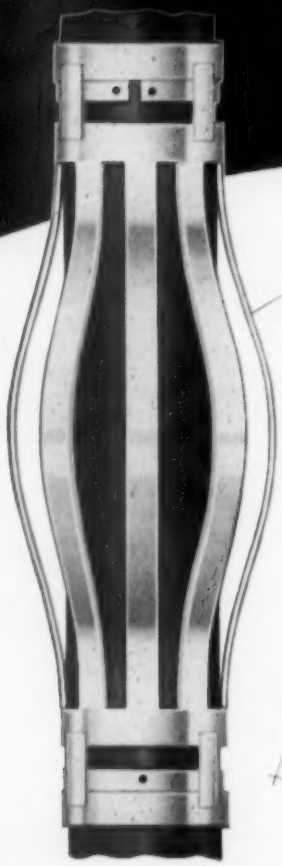
✻ Either will provide BEST Casing "Centering" because only BAKER Casing Centralizers give you Maximum Centering Force throughout the Cementing Area.



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BAKER MODEL "G" Casing Centralizers are popular with those operators who prefer a centralizer that is slipped on the casing and retained in exact position by Stop Rings. They exert MAXIMUM CENTERING FORCE even after the most rugged trip to the point where the actual centering must be done. Made in sizes to run on casing from 4½" to 16" O.D., with bowed height of springs from 1¼" to 2"—thus providing different sizes for *extremely-close* tolerances, *less-than-normal* tolerances, and *normal* tolerances. ALL Baker Casing Centralizers are the BEST centralizers obtainable—just choose the model *best for you.*

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BAKER MODEL "H" HINGE-LOK Casing Centralizers are universally used by operators who prefer a centralizer hinged for mounting over a coupling. Your choice of four different ranges ensures proper "reach" (bowed height of springs) to provide adequate all-around cementing space. The four ranges of the MODEL "H" HINGE-LOK Centralizer provide MAXIMUM CENTERING FORCE, without snubbing, from the extremes of *less-than-normal* tolerances to *greater-than-normal* tolerances, and where *extensive hole irregularities* are anticipated.

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BAKER Casing Centralizers

Oil faces new problems for new times ahead

IF an old-time oil man who had been out of touch with things for the past dozen years or so had shown up at the annual meeting of the American Petroleum Institute in San Francisco last week he would scarcely have known he was at an oil gathering.

This twentieth-century Rip Van Winkle would have found discussion of producing, transportation, and refining oil relegated to relatively minor segments of the 4-day program giving way to papers on subjects he had never heard of in connection with the oil business.

He would have been flabbergasted at the amount of attention given such seemingly foreign subjects as building and financing highways, maintaining employes' health, improving the educational system, getting business men into government service, and what conditions will be like in 1965.

IF THIS SEEMS STRANGE to any oil man today, he is himself a Rip Van Winkle, not abreast of the times. For the oil industry, like all industry, is undergoing a revolution. To keep its place in today's society it must give attention to many things in addition to the technical problems of its own operations.

While technological progress and the research on which it rests are more important than ever, any company which aspires to maintain or improve its position in the future must also concern itself with other aspects of the new competition. It must make long-range plans on market potentials, competition among commodities, capital expansion, and personnel development.

The most successful companies 10 years hence will be those which have had the wisest management, management which can obtain and best utilize technical talent. Competition for both management and technical personnel will be keen, for good men will be industry's greatest shortage.

To compete for the needed specialists, management must give more heed to human relations. A company must attract personnel by the living conditions and advancement opportunities of its employes, by its standing in the community, by its demonstrated growth potential, by its broad long-range planning.

SO THE A.P.I. IS WISE to put so much stress on these things at its top-drawer, over-all meeting. There are other and more appropriate forums for discussion of the increasingly complex technical developments, but here the accent should be on running a business properly.

To preserve and make use of its technical progress, the oil industry must make progress in its human relations—relations with Government, customers, employes, and the public. This A.P.I. meeting shows that it is aware of this and is doing things about it.

What's the Best Temperature

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WHY is it the best for these critical gas-fired furnace temperature applications? Because *both* the TRANSAIRE Transmitter and the TRI-ACT Controller respond practically instantaneously and with the right amount of correction to control the slightest temperature variation. Result—*truly uniform furnace outlet temperatures*. In fact, field experience has proven that there is no better control system on the market at any price for these applications. Here's why:

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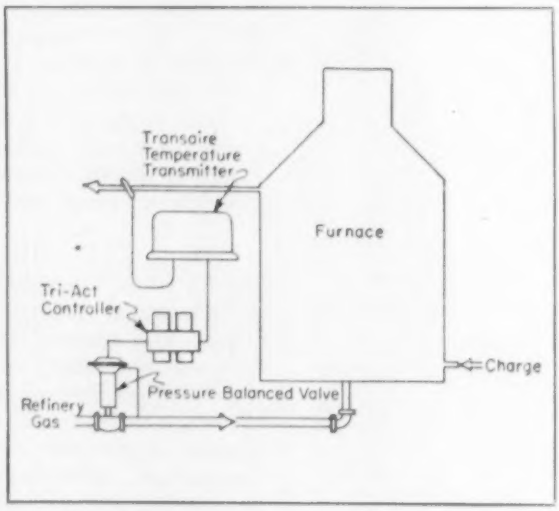
3. The sensitivity of the TRI-ACT controller (1/10 of 1%) provides instantaneous corrective valve action.

4. The TRI-ACT circuit (PRE-ACT®—rate action—ahead of reset and proportional) permits higher PRE-ACT settings which produce corrective valve action of just the right magnitude for straight line control.

The TRI-ACT controller is the *only* pneumatic controller that has such an advanced circuit.



The TRANSAIRE Transmitter, with its short range spans of 100, 200 or 400°F. is particularly adaptable to these high temperature applications. In fact, it provides the same quality of control on cat crackers with temperatures up to 1200°F.

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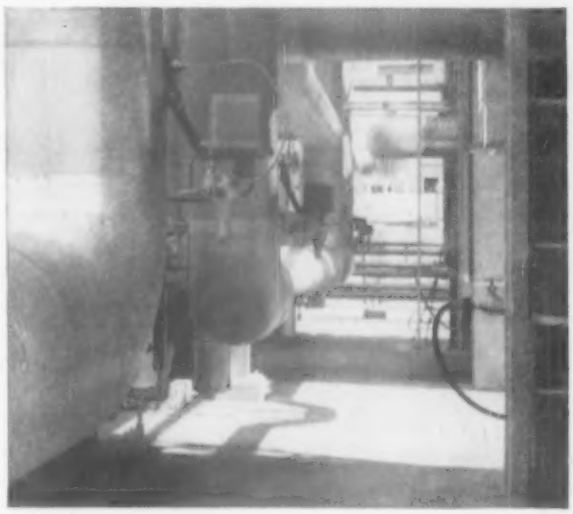
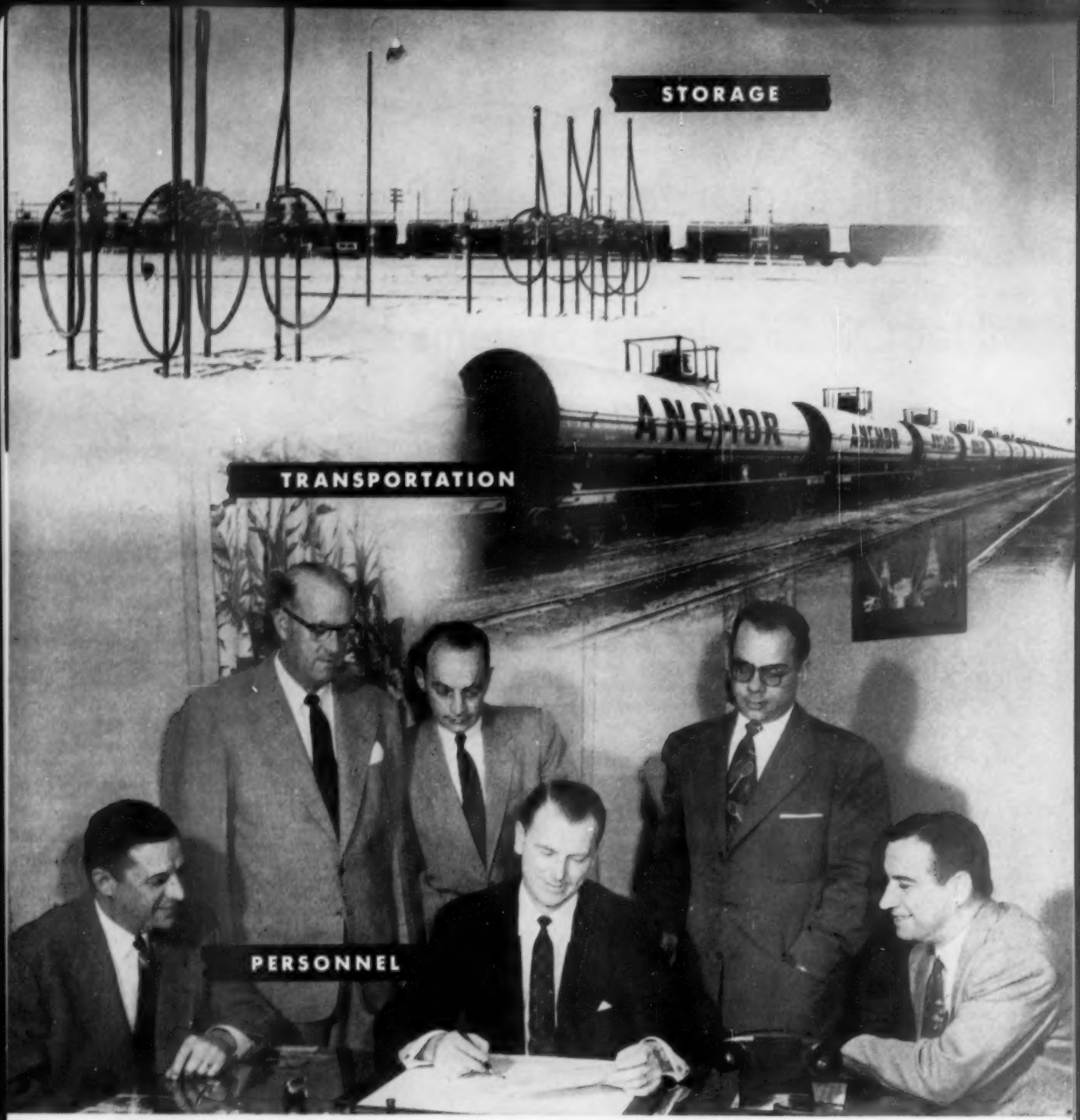


Taylor TRANSAIRE *Temperature Transmitters in use on Reformer Reactor Pre-Heaters at a well known SouthWestern gasoline plant.*

Taylor Instruments **MEAN ACCURACY FIRST**

Transmitter, coupled with costs the LEAST!



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Current and significant in . . .

The Industry This Week

Refining

• **Texaco will start building a 20,000-bbl. daily refinery** at Santiago de Cuba this month. Emphasis will be on fuel oil which will comprise 50 per cent of the output. Completion is due early in 1957. P. 134.

Wilshire Oil sells refining, pipeline, and marketing properties to Malco Refineries. Malco plans to charge 50 per cent foreign crude to the 24,000-bbl. daily Norwalk, Calif., refinery. P. 128.

Offshore

• **Gulf Oil has moved offshore operations 48 miles out to sea.** This new record was set at a wildcat spudded off Cameron, La. It's 8 miles farther out than the previous record holder being drilled by Phillips. P. 126.

Exploration

• **A Stonewall County wildcat** has thrust the Cambrian Trend fields into the West Central Texas spotlight again. The prospect indicates a 50-mile northward extension of Cambrian production. P. 128.

Italy's monopoly company claims a new oil strike, the third made possible by Petrosud exploration. And the monopoly is going to produce the wells while Petrosud's remain shut-in. Meanwhile debate rages on over the new oil law which has foreign firms on the short end of a 60-40 profits split. P. 133.

The world's deepest well continues to probe deeper into the earth. The Richardson & Bass test in Louisiana has hit 21,766 ft. P. 126.

Production

• **A new thermal drive using steam** has resulted in 80 per cent oil recovery on a small test plot in southeastern Illinois. In the process, steam and hot combustion gases were used as driving agents. Hot air was also introduced as an oxidizer for underground combustion which aids the drive. P. 131.

A new producing-depth record for active wells has been set by Shell. The record-breaker is a Weeks Island well producing from 17,558-84 ft. The well is producing from 30 ft. below another Weeks Island well that previously held the record. P. 130.

Pipelines

• **Trans-Canada Pipe Line's chances keep getting better.** Tennessee Gas Transmission, whose markets make the big line possible, has become a partner in the Canadian company. Reports last week were that T.G.T. had acquired a one-third interest in the huge line. P. 131.

Forecasts

• **A.P.I. delegates got a look into the future last week.** Visiting experts handed them this outlook: Total U. S. petroleum demand will reach 14.5 million barrels daily by 1965. The rate of growth in demand for both oil and gas, however, will slow down. As these fuels complete displacing other fuels their rate of growth will depend on the national economy.

Daily petroleum consumption of the free world, including the United States, should reach 17 to 18 million barrels in 5 years. The trend toward deeper drilling means a rising increase in demand for steel—about 2,600,000 tons annually the next 5 years and double that by 1971. Oil industry capital expenditures may exceed $9 billion by 1965.

SESSIONS WERE WELL ATTENDED, as this photo shows. This picture was made during the Monday public-relations meeting.

A.P.I. Accent on Growth, Opportunity

SAN FRANCISCO.—Vistas of a new era of economic expansion and business opportunities were opened to the oil industry by speakers at the thirty-fifth annual meeting of the American Petroleum Institute here November 14-17.

The dominant note throughout the meeting was the future and how to prepare for it and make the most of it. Bits and pieces of this theme, culled from a score of speeches at general and group sessions, form a mosaic which presents this picture.

Demand for petroleum products, both here and abroad, will continue to increase. In this country it may increase 50 per cent within 10 years—and double by 1975.

Problems and opportunities . . . The nation has undergone an economic revolution and laid the basis for tremendous expansion of consumption and capital investment. Business must take this into account and pay far more attention to long-range planning.

But problems and responsibilities accompany these opportunities, particularly for oil. Change will be as much a feature of the future as growth, and operators must stay alert and be ready to adapt themselves to new conditions if they are to maintain their competitive and earnings position.

Oil will be harder to find and more expensive to produce. Products specifications will change, and their relationships to each other will shift. Competition among fuels will get more intense, even though the total energy market will be vastly larger.

In the new economy of abundance, people will have money to spend but they will be choosey how they spend it, and there will be plenty of supplies and suppliers for them to choose among. Competition will be sharper than ever. The successful enterprise will be the one that does the best job of selling and service.

More money to invest . . . Capital expenditures for new production capacity will rise to unheard-of heights.

In petroleum they may reach 9 billion dollars a year within a decade. Much of this will be plowed-back earnings, but the public will have large savings to invest, directly and through institutional lenders, in business expansion. Investors will favor those enterprises with growth potential, that plan ahead to insure their future position, that conduct research into new products and processes, and that have superior management.

Good business management will be at a premium. To meet this need, industry must take an active hand in helping our educational system turn out more and better scientists, engineers, and administrators.

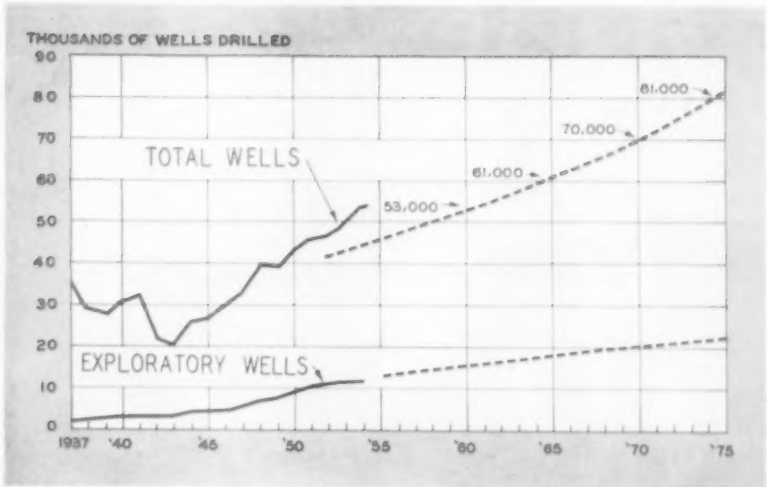
Public relations era . . . For all the scientific and technical progress envisioned, it will be an era of human relations. The customer, the employe, the neighbor will be kings. The health, safety, and welfare of employes will be a prime concern of management, and so will the standing of the company in the community.

Oil men must become extroverts, maintaining friendly relations with their dealers and customers, telling the public constantly what they are doing and why, explaining patiently that the maximum of free enterprise and competition is the basis of industrial progress.

For there will still be those to whom business is suspect, who want more government regulation and even state socialism. Oil will continue to be their prime target, so oil men must fight harder to keep government out of business. And the best way to do this is for them to get into government themselves.

There will be crises in government-industry relations—there are many at this very moment. To meet them the oil industry must develop unity, compose its internecine strife, adopt an over-all viewpoint, and present a united front against forces that would destroy private enterprise before it can make good its promises for the future.

How some of the A.P.I. speakers developed various phases of this theme is detailed in the following pages.



Is Industry Overdrilling?

Socal economist says we can reduce drilling pace during next 5 years and still maintain reserves at safe level

SAN FRANCISCO.—The oil industry can slack off drilling for a few years and still maintain its reserve producing capacity for emergencies.

In 1960 the industry need drill only 53,000 wells, 2,000 fewer than are being drilled this year. Austin Cadle, Standard Oil Co. of California economist, told a meeting here of petroleum-industry buyers.

However, beginning in 1960, the number of wells needed will increase annually and will reach 81,000 in 1975, Cadle said.

"In recent years we have been drilling wells at a rate faster than required to meet current demands and have built a sizable reserve capacity to produce," Cadle told the buyers.

A look at 1975 . . . In a 20-year forecast, Cadle sized up energy demands and came to these conclusions:

. . . **The United States population** then will be 215,000,000, compared with something over 165,000,000 now and only 116,000,000 in 1925.

. . . **Per capita consumption** of energy, in crude-oil equivalent, will be more than 56 bbl., compared with 40 bbl. a year or two ago and only 23 bbl. in 1900.

. . . **Crude-oil production** will be more than 11,000,000 bbl. daily, almost twice the 1953 figure.

. . . **Natural-gas liquids** output will be 1,400,000 bbl. daily.

. . . **Imports** will be much higher than their present volume.

Steel needs to rise . . . The trend toward a greater average well depth will continue, Cadle told the buyers. This, he said, will mean a continuing increase in steel demands.

Annual footage required during the next 5 years will run about 223,000,000 ft. During the 1971-1975 period "it may average about twice that figure," he declared.

"It is estimated then that the average of 2,600,000 tons per year needed from 1956 to 1960 will increase to 5,900,000 tons for the period 1971 to 1975, with large increments in each intervening period."

In addition to drilling requirements, Cadle said, a growing amount will be necessary for tankage, refineries, pipelines, and other uses.

In 1975 total steel needs of the oil industry were forecast for 12,000,000 tons, compared with approximately 5,000,000 tons in 1954.

It was further predicted that the oil industry will take an increasing percentage of all steel produced.

Other things to come . . . New forms of energy will appear on the scene before 1975. But, Cadle said, the role of solar energy and nuclear fission or fusion is so fuzzy now that "any prediction would be extremely speculative and possibly meaningless."

Synthetic petroleum products by 1975 could have their place in the fuels picture, "but the extent to which these will be economically competitive is also quite conjectural."

Electric output is due to soar, Cadle said, and fuel oil and natural gas will supply a major portion of the fuel required to generate this increase.

Electric output may well be 1.54 trillion killowatt-hours in 1975, Cadle said. In 1954 the figure was only 557 billion kilowatt-hours.

Cadle described the new forms of energy as "beneficient forces that promise to better the world." The increased industrial activity and higher standards of living they may bring about would automatically increase demands for oil products, he said.

Early Arrivals Line Up to Register

This was the scene Sunday morning as registration opened in the lobby of the Fairmont Hotel. Although registration did not open until 10 a.m., and the official program of the meeting wasn't to begin until the next day, more than 2,500 persons registered on November 13.

Genial, cigar-smoking Hamon . . .

. . . wants new era of harmony.

. . . He's hard man to disagree with.

Jake Hamon takes on tough job as . . .

. . . A.P.I. Names Independent Chairman

THE first independent producer ever to hold the job has taken over as chairman of the American Petroleum Institute. He is Jake L. Hamon, an independent with a broad view and a tolerant attitude.

And Hamon certainly is no stranger to the problems of the entire oil and gas industry. He has been on the board of directors of A.P.I. 20 years. He also has been active in a long list of industry association assignments for an even longer period.

In his easy-going manner, Jake explains his outlook like this:

"I guess I'm what you'd call a middle-of-the-roader. I've never been anything but an independent oil producer. But I've been dealing with the other elements of the business for so long that I guess I can see their viewpoints too."

Teamwork his aim . . . The greatest trouble in the oil industry today, the new A.P.I. chairman contends, is factional differences. They are tearing apart the various groups and divisions. Each has its own special interests.

He believes in achieving harmony by compromising and adjusting these differences so the industry will present a united front on the big issues. He names these issues as imports, depletion allowance, gas regulation, jobber woes, and similar matters.

"The great trouble in the industry is that we're being torn to pieces," he says. "The jobbers are complaining of their lot. The independents are raising cain about imports. The depletion allowance is getting more and more precarious. And the Harris bill has stirred up animosities which have been aired too publicly.

"I don't have any brand-new or radical ideas about how to accomplish harmony. All I can do is just preside at meetings and try to get people to work out agreements."

Just an old shoe . . . Hamon has had plenty of experience with problems like these. He has the temperament for getting people to submerge their minor differences.

Always genial, and as informal as an old shoe, his broad grin and earthy talk have a way of clearing the atmosphere when things get tense. He has the air of never worrying about anything. He'll puff his ever-present cigar and listen awhile, then hold it a couple of inches from his face, grin broadly, and make a homely observation that cuts through the conversational fog right to the point of the problem. He's a hard man to disagree with.

Mostly a lone wolf . . . It's an odd coincidence that both Hamon, the new board chairman, and Frank Porter, the salaried president of A.P.I., were early Ardmore, Okla., operators.

Frank went to Oklahoma City and became head of a drilling contracting and oil-producing firm. Jake went to Dallas as an independent operator.

Hamon is one of those individual independent operators—almost a rarity in these days of corporations and intricate finance. He has never formed a corporation. He has always conducted his extensive producing operations as an individual under his own name or as a partnership.

The partnership of Cox & Hamon was amicably dissolved a few years ago, and Hamon has since operated the way he started—as an individual proprietor. He's probably the best-known individual producer in the country, largely because of his many years of activity in industry affairs.

Novice at Ranger . . . Hamon is a native of Lawton, Okla., receiving his education there and at University of Chicago. He entered the oil business in 1921 when he left school to drill a well in the Ranger field of Texas. He's been a producer ever since.

Hamon has centered his oil activities during the intervening 34 years mostly in Oklahoma, Louisiana, Mississippi, New Mexico, and Texas. He admits occasionally taking a flyer on a deal in some other state.

Hamon has been a president of Mid-Continent Oil and Gas Association and director of A.P.I. and Independent Petroleum Association of America.

The new A.P.I. chairman confides he once liked to relax on a hunting trip. "But the deer got so little and the ducks so scarce on Red River" his chief relaxation now is cards.

Lubes, Fuel Work as Team

Package marketing proposed for new products since peak performance depends on their being used in combination

SAN FRANCISCO.—The oil industry is missing a bet these days in its methods of selling gasoline and lubricating oil. Instead of promoting these two important products separately, companies should stress their interrelationship to promote improved performance in today's cars.

These thoughts were stressed before the Lubricating Session sponsored by the A.P.I. Division of Marketing. In presenting this concept, Howard Vesper, vice president of Standard Oil Co. of California, outlined how benefits from new fuel and lubricant developments could best be realized by the motoring public.

There is a real need for the industry to realize that thinking has changed, he said. In these times, when engine design and operation impose a new high degree of severity, it is imperative that gasoline and lubes be used in a combination which will give best results.

The improved gasolines of today are due to get much better. In addition to the much-publicized advances in octane, several other improvements in fuel quality are being made. Sulfur content has been cut from 0.25 per cent a few years ago to as low as 0.1 per cent in many current fuels. This has greatly reduced lube-oil contamination by sulfur combustion products.

Carburetor gumming, a result of increased traffic driving, is being curbed by new gasoline-additive combinations. Gasolines with cleaner-burning characteristics contribute to control of engine deposits.

The new multigrade oils reduce engine friction and wear. They also retard the formation of engine deposits, and make possible easier starting.

The package concept . . . But neither the better fuels nor the improved lubes will give their full measure of performance unless they are used in proper combination, continued Vesper.

Improved gasolines increase mileage by reducing rich idling. Multigrade oils extend mileage by reducing engine friction. In tests on a taxicab fleet, mileage was increased 6 per cent with a combination improved gasoline and multigrade lube. The benefit was split about 50-50, each contributing about half of the savings.

Improved, clean-burning fuels and multigrade oils both contribute to lowered octane requirement buildup. As compared with conventional lubes, the newer grades give a reduction of from two to four numbers, reported Vesper. In theory, a two-number saving on octane buildup would offset an investment of about $4 million in plant facilities in a 100,000-bbl. per day refinery.

New lubricating horizons . . . Recent trends in mechanical design are going to need new attention from lube manufacturers.

Some of these higher requirements were outlined by S. H. McAllister and S. J. Beaubien of Shell Development Co. In the automobile, load-carrying problems are appearing in the valve mechanism and in the hypoid differential gears. The valve mechanism problem is complex, with fatigue and scuffing proving sensitive to the metals used, the operating conditions, and engine design. Hence additives useful in one engine design were not found suitable to another.

A.P.I. Picks Two New Officers

SAN FRANCISCO.—The American Petroleum Institute has a new board chairman and vice president for transportation. All other officers were reelected at the annual meeting here last week.

J. L. Hamon, independent oil producer of Dallas, was elected chairman of the board. He succeeds P. C. Spencer, president of Sinclair Oil Corp., New York.

Frank O. Prior, president of Standard Oil Co. (Ind.), Chicago, is the new vice president for transportation. He succeeds Charles S. Jones of Richfield Oil Corp., Los Angeles.

Frank M. Porter, president of Fain-Porter Drilling Co., Oklahoma City, was reelected president. Other officers reelected were:

A. W. Thompson of A. W. Thompson, Inc., Houston, vice president for production;

E. B. McConnell of Standard Oil Co. (Ohio), Cleveland, vice president for refining;

J. G. Jordan of Shell Oil Co., New York, vice president for marketing;

B. B. Jennings of Socony Mobil Oil Co., Inc., New York, treasurer;

Lacey Walker, American Petroleum Institute, New York, secretary.

Directors . . . The A.P.I. also elected eight new directors to fill vacancies on its board.

They are: F. M. Banks, Southern California Gas Co., Los Angeles; Harold Becker, Houston Oil Co. of Texas, Houston; E. A. Johnson, Schlumberger Well Surveying Corp., Houston; F. M. Mayer, Continental Supply Co., Dallas; D. A. McGee, Kerr-McGee Oil Industries, Inc., Oklahoma City; H. C. Pyle, Monterey Oil Co., Los Angeles; David Proctor, Gulf Oil Corp., Pittsburgh; and S. H. Elliott, Standard Oil Co. of Ohio, Cleveland.

F. O. PRIOR
. . . New vice president.

Club elections . . . Several organizations within the industry held annual meetings during the convention and elected officers. These included:

W. K. Warren, chairman of Warren Petroleum Corp., Tulsa, president of the Twenty-Five Year Club, succeeding R. G. Follis of Standard Oil Co. of California.

J. L. Burke, president of Service Pipe Line Co., Tulsa, president of the Pipe Liners Club, succeeding Loren F. Kahle of Standard Oil Co. (New Jersey).

Paul J. Bond, Pure Oil Co., Chicago, president of the Transportation Club, succeeding Lee R. Cowles, Standard Oil Co. (Ind.).

A.P.I. Meeting

Slower Demand in Sight

Oil's growth may not be so rapid as competing fuels are finally displaced; future is geared to general U. S. economy

SAN FRANCISCO. — The rate of growth in demand for petroleum products and natural gas will slow down. This will occur when these fuels complete the process of displacing other fuels.

Thereafter the demand will grow only as fast as the general economy expands.

That is the conclusion presented to the A.P.I. statistics session by N. B. Guyol, staff statistician of the United Nations, New York.

Guyol said end of the displacement period will vary among the individual products. But he believes all of them will reach this point by 1965 and some considerably earlier.

Efficiency a factor . . . A declining growth rate in petroleum demand is due to another factor: increased efficiency of fuel use.

Guyol's study included details on the differences between energy consumed and work performed. Thus he used useful energy obtained as basis for estimating true market demand.

Estimates of future energy requirements will almost certainly understate requirements if they are based on rates of change in total energy consumption rather than useful energy consumption. Guyol explained this is because they fail to take into account effects of changing efficiencies of fuel use.

Total energy consumption has increased about 2¾ per cent per year. But useful consumption increased at the rate of 4 per cent.

Coal on skids . . . The biggest factor in growth of petroleum demand has been displacement of coal.

Guyol pointed out while real requirements were growing at a rate of 4 per cent per year, oil requirements increased at 6 per cent, and natural gas at 8½ per cent.

One-third of the new demand for oil and more than one-half of the new demand for natural gas simply were to replace other sources of energy. When all the displacement possible has taken place, the demand for oil may be expected to fall by one-third. Gas demand will drop by one-half.

Electricity big gainer . . . Guyol said the most rapidly growing of all fuel markets in recent years has been for electric-power generation.

Fuel consumption in this industry has risen an average of 7½ per cent per year. Use of fuel oil here rose 10 per cent per year and natural gas nearly 12 per cent. Future gains in efficiency will be slower than in the past. So this market will increase at about the same rate as power generation which averaged 9½ per cent since 1937.

He predicted the requirements of natural gas for power generation will reach 11 billion cubic feet per day in 1965, for oil 550,000 bbl. per day, and for coal 500,000 tons per day.

Home heating . . . Household heat requirements have increased 4 per cent per year. But home consumption of distillate oils has increased twice as rapidly and natural gas 2½ times as fast.

Guyol predicted that coal will be completely displaced from household markets by 1960. The combined residential market for oil and gas will then grow by only 4 per cent per year instead of its recent 9½ per cent rate.

The competition between oil and gas will then be intense.

Outlook in transportation . . . Use of petroleum products in this field will either drop or show a slower rate of gain. Guyol gave this picture:

. . . Inland transport. Real energy requirements here have risen at the rate of 4¼ per cent per year since 1937. But actual energy consumption rose much less rapidly and actually has declined since 1947. This is due largely to dieselization of railways and increased use of oil and gas pipelines.

Guyol estimated the displacement here is almost completed. Petroleum distillates now provide 85 per cent of the energy used in inland transport.

. . . Overseas transport. Coal has almost entirely been displaced here so the rate of growth of oil demand will not exceed 5 per cent per year.

However, Guyol said it may drop below that since there seems to be a trend toward motorships. A barrel of distillate in a motorship will do the work of 1½ to 2 bbl. of bunker fuel in a steamship.

Farm and factory . . . Agriculture still is a big field for further expansion of distillate fuels.

Guyol estimated a 25 per cent rise by 1960 and a 50 per cent increase by 1965. This will bring total farm use of gasoline and tractor fuel to around 400,000 bbl. daily.

Industrial requirements for useful heat have been growing at close to 4 per cent yearly. But the industrial market for natural gas has increased 8 per cent per year, due primarily to displacement of coal.

If this rate of growth is maintained, gas will displace all coal in industry by 1963 and all oil a few years later. Guyol does not expect this to happen. But he said the industrial market for natural gas by 1960 will not rise faster than 5 per cent.

Pipeline Problems Come in for Discussion

Four early arrivals at a Sunday morning session of the Division of Transportation's subcommittee on pipeline construction practices begin hashing over the day's work. Left to right are J. A. Rupf, Socony Mobil Oil Co., Inc., Wichita; Harry K. Phipps, Socony Mobil, Wichita; W. B. Haas, Northern Natural Gas Co., Omaha; and Paul Reed, pipeline editor of The Oil and Gas Journal, Tulsa.

Asphalt Promotion Urged

President of Asphalt Institute says program will mean easier tax burden, higher materials and products sales

SAN FRANCISCO.—The oil industry can kill two birds with one stone if it will throw its support behind the campaign for more asphalt highways.

Large as it is, the potential market for asphalt is a minor matter compared with the benefits which could be realized from gasoline and lube-oil sales, and from stretching gas tax dollars.

The broad market implications of a concerted drive by the industry is of interest to all oil companies whether they make asphalt or not. J. E. Buchanan, president of the Asphalt Institute, outlined two broad reasons for industry-wide interest in the asphalt road-building program.

In the first place, he said, the critical need for more and better highways threatens to limit over-all vehicle use. Last year, 58 million motor vehicles chalked up about one-half trillion miles of travel. This year, the vehicle count runs to about 61 million. But more people driving more cars will mean a bigger petroleum market only if the cars are used, and this calls for more adequate roads.

The tax angle . . . In addition, the oil industry has a real interest in how the gas-tax dollars are spent.

Increased use of asphalt, compared with higher-cost concrete, will result in more miles of better highways per tax dollar. If the industry can put this point across with road builders and the public, it will relieve the pressure for higher gasoline taxes to finance the tremendous program which is needed.

Today, we have about 919,000 miles of paved streets and highways in this country. Of this, 750,000 miles are surfaced with asphalt, as compared with 150,000 miles in concrete. A large segment of this mileage is in bad need of widening and surface improvement. Asphalt best meets this particular need, said Buchanan.

The 1,240,000 miles of unpaved but improved roads represent a major asphalt market, since many thousands of miles should be paved to meet increased traffic demands. Further, the 1,200,000 miles of country dirt roads include additional mileage which will require paving in the face of a continuing shift to the suburbs and the growing need for better feeder systems.

Why use asphalt . . . Buchanan cited figures to back up his contention that asphalt will best meet these growing highway requirements. First-cost advantage favoring heavy-duty asphalt over concrete will run 20 to 50 per cent, he said. For example, competitive bids for the New Jersey Turnpike reflected an original saving of $5,457,134 favoring flexible asphalt over rigid concrete. A study made for the new Massachusetts Turnpike showed that $25,000,000 could be saved by choosing asphalt over concrete.

J. E. BUCHANAN

Maintenance costs also favor asphalt. The Massachusetts study estimated that heavy-duty asphalt paving would save $45 per mile per year in contrast with concrete highway maintenance. When the Oklahoma Turnpike was in the planning stage an impartial survey was made of maintenance records of 17 states where costs of asphalt and concrete roads were kept separately. The over-all picture showed a saving of $22 per mile per year in favor of asphalt.

When the last session of Congress was wrestling with President Eisenhower's multibillion-dollar highway proposal, it did not overlook petroleum products as a source of more revenue, said Buchanan. Since every increase in the gasoline tax may be regarded as permanent, the industry faces the inexorable law of diminishing returns unless tax increases can be modified.

What to do . . . Hence, concluded Buchanan, the oil industry's position is clear. It should tell the asphalt story to stockholders, royalty recipients, and credit-card holders. Service-station personnel should be educated on the subject. And finally, the industry should tell its story to the general public through advertising.

Journal Coverage at the A.P.I.

The Oil and Gas Journal had seven veteran editors on hand in San Francisco to bring you this comprehensive coverage of the A.P.I. meeting.

Representing the Journal were K. B. Barnes, editor; C. O. Willson, consulting editor; Henry D. Ralph, chief editorial writer; Ted A. Armstrong, news editor; George Weber, refining editor; David H. Stormont, West Coast district editor; and Paul Reed, pipeline editor.

The Journal's Latin American affiliate, Petroleo Interamericano, was represented by Oscar B. Irizarry, publisher and editor.

Big Spending Ahead

Industry expenditures may rise to $9 billion in '65

SAN FRANCISCO.—Capital expenditures of the oil industry—5.7 billion dollars in 1955—will reach or exceed 9 billion dollars by 1965.

This growth will be dictated by the increasing cost of finding new reserves, according to Lyon F. Terry, vice president of Chase Manhattan Bank, New York.

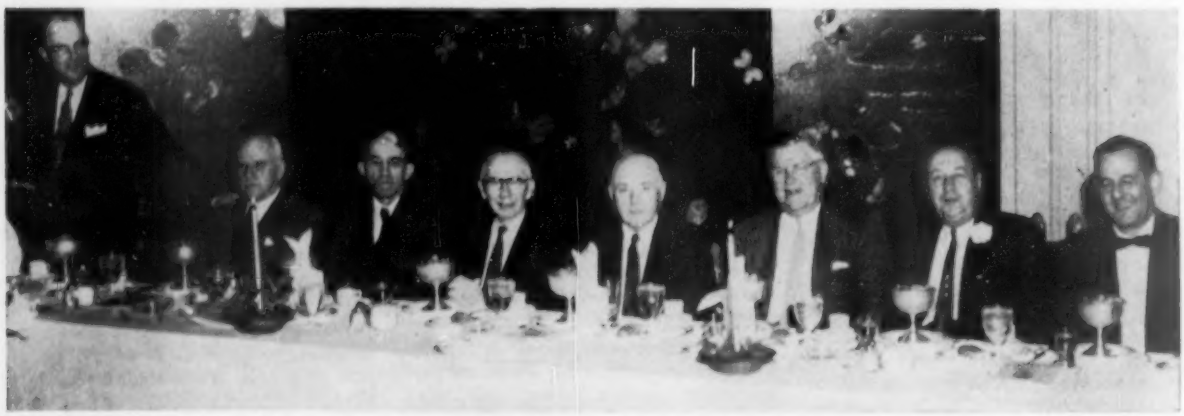
Every barrel of oil produced must be replaced. In addition, new reserves must be found to meet the constantly rising demand, Terry told a financial and accounting group session here.

These exploration and production burdens are compounded by the fact that the cost of finding a barrel of new oil already has risen from $1.22 in 1949 to $1.76 and is certain to go higher.

In addition to the new reserves cost, Terry said, additional capital expenditures will be required to improve and expand the country's refinery, pipeline, shipping, marketing, and petrochemical facilities.

It is expected, Terry said, that the oil industry as a whole will borrow 12 to 15 per cent of the money it spends in capital outlay. This would mean that the United States oil industry may increase its indebtedness by $1 billion or more per year by 1965.

ANNUAL PIPELINERS' CLUB BANQUET found this group at the head table. Left to right are R. H. Lynch, vice president, Keystone Pipe Line Co., Philadelphia; J. W. Emison, president of Texas Pipe Line Co., Houston; L. H. True, president of Magnolia Pipe Line Co., Dallas; J. M. Linehan, president of Mid-Continent Pipe Line Co., Tulsa; Ralph K. Paine, manager of the pipeline department of Standard Oil Co. of California; O. Q. Lomax, president of Humble Pipe Line Co., Houston; Charles Bunje, retired, Santa Monica, Calif.; and J. L. Burke, president of Service Pipe Line Co., Tulsa. In the foreground are F. B. Neptune, left, vice president of Phillips Pipe Line Co., Bartlesville, Okla.; and Millard Neptune, president of Egyptian-American Oil Co., Cairo.



PART OF THE HEAD TABLE at the Pipeliners' banquet. Left to right are J. H. Wood, Jr., vice president of Atlantic Pipe Line Co., Dallas; Fayette B. Dow, Washington; Wallace R. Finney, retired, Hillsborough, Calif.; R. B. McLaughlin, chairman of the board of trustees of Texas Pipe Line Co., Houston; Clark H. Kountz, retired, Newport Beach, Calif.; W. C. Kinsolving, president of Sun Pipe Line Co., Philadelphia; J. L. Latimer, president of Magnolia Petroleum Co. and chairman of Magnolia Pipe Line Co., Dallas; and Oliver Klinger, Jr., Pipe Line News, Bayonne, N. J., and club secretary.

Pipeline Gains Reviewed

Current design and construction problems also discussed in technical papers presented during committee meetings

SAN FRANCISCO.—Petroleum pipeline mileage in this country will have increased from 160,000 miles in 1950 to at least 180,000 miles by the end of 1955.

This growth was described by Gordon C. Locke, executive secretary, Committee for Pipeline Companies, before the A.P.I.'s Central Committee on Pipeline Transportation.

Locke said pipelines deliver 76 per cent of the crude oil reaching refineries and 18 per cent of the refined products for consuming points. He predicted many future pipelines will be devoted exclusively to moving butane and propane.

Pipeline companies reporting to the Interstate Commerce Commission spent more than $1.8 billion for new construction and improvements between 1946 and 1954. In this 9-year period, 41,000 miles of principal petroleum pipelines have been built, including 23,000 miles of crude lines and 18,000 miles of products lines. Part of the mileage replaced older multiple small-diameter systems.

Transportation revenues are running 8 per cent above last year, Locke reported. Volume of oil moved is exceeding 1954 by 8.5 per cent. Pipeline tariff rates were said to be about the same as 15 years ago in contrast to sharp increases in other transportation rates.

Design and construction . . . Pipeline design and construction were discussed in papers delivered before the subcommittee on pipeline construction prac-

TABLE GROUP at the Pipeliners dinner consisted of, left to right, J. W. Meehan, president of Pure Transportation Co., Chicago; A. E. Harnsberger, general manager of transportation of Pure Oil Co., Chicago; John W. DeGroot, president of Tuscarora Pipe Line Co., Ltd., Harrisburg, Pa.; Phelan H. Hunter, president of Interstate Oil Pipe Line Co., Shreveport; and Fred G. Cottle, general manager of transportation for Imperial Oil, Ltd., Toronto.

tices and the Committee on Pipeline Technology.

No failures due to thin wall pipe in casings were reported at highway and railroad crossings. However, it was noted that railroads have been asking for heavier wall pipe in casings because of their use of the rigid conduit formula. The industry regards steel pipe as a flexible conduit, and has justified its position.

Procedures recommended in A.P.I. Bulletin 1,105, "Construction Practices for Oil and Products Pipelines," have been widely applied since it was issued last March, according to reports from several major companies. This bulletin combines ideas of 25 companies for the benefit of the entire industry. It is not a code but a description of satisfactory practices.

The Central Committee on Pipeline Transportation gave permanent status to A.P.I. Bulletin 1,104 on oil and gas pipeline field-welding practices. The word "tentative" was removed from the original title.

Most pipe now is being ordered with a 30-degree bevel, a discussion of bevel types in the subcommittee on pipeline construction practices showed.

A segment bend of 15 degrees was recommended by a California firm to facilitate draining close to gate valves in flat country. This practice has been used recently by several West Coast companies.

Another pipeline company recommended installation of bypasses for valves on lines transporting viscous crude oil. By bypassing 5 per cent of the stream, the waxy oil ahead of the valve would be stirred up.

Contractors were urged to avoid scratches or notches on pipe during construction to prevent brittle fracture. Stop rings on the outside aid in checking the extent of brittle fractures. It was pointed out that greater wall thickness would not overcome the danger in "notch-sensitive" type steel. Rather than go to a thicker wall, it was recommended that diameter be increased to carry less pressure in the line, particularly at critical locations.

A committee of 25 members from the A.P.I. and American Standard Association is developing a new Section 9 for the design and testing of crude and products piping. They will meet next March in St. Louis.

Officers of the group started 2 years ago, include O. W. Heyden, chief engineer, Shell Pipe Line Corp., chairman; S. G. Kershiner, vice president, Texas Pipe Line Co., vice president; and Morgan Martin, engineer, Gulf Refining Co., secretary. The committee is composed of representatives from manufacturer and pipeline companies. It is expected to publish a bulletin presenting the new Section 9 late next year.

Crisis in Classrooms

Dwindling science students creating manpower shortage in oil industry; Porter sees solution in quick, private help

SAN FRANCISCO.—The dearth of qualified engineers and scientists is one of the most critical shortages facing the petroleum industry.

And it will become much more troublesome in future years unless corrective steps are taken now, Frank M. Porter informed the American Petroleum Institute in his presidential address.

"This is an educational problem rebounding as a business problem, and the only solution that will relieve business must be applied in the classroom," he explained.

Porter said the decline in numbers of high school students taking courses in science "is a record worth the worry of every oil man, and, more than that, of every American. For this is a record that threatens the very security of our nation.

"Let us hope it need never be said that the battle for the free world was lost in the high schools and colleges of America, high schools and colleges that failed to train enough young people to hold our leadership in research, engineering, and scientific discovery."

Porter said the only obstacle to solving this country's educational problem is the lack of determined leadership.

He added the problem can be solved without federal intervention, largely by private industry.

Among things which oil companies might do, Porter listed:

. . . **More systematic** scholarship and educational grants to colleges.

. . . **Industry grants** for fundamental research as well as research of direct financial value.

. . . **Moral support** for education by helping increase the pay and prestige of teachers.

. . . **A continuing campaign** to interest and finance young people in scientific training.

Porter commended a new organization known as the Frontiers of Science Foundation of Oklahoma. It is supporting a program of action in the improvement of science education at all levels of instruction. He concluded:

"It seems to me that this pattern of local action is one which must be assumed by other areas and carried out if we are really to achieve any substantial progress toward the improvement of the quality, as well as the quantity, of the scientists and engineers who will be produced by our educational institutions in the next decade.

"There is so much to be done and so many effective ways of doing it. The point is: It's urgent that the subject be ventured into, and now. Today it's a problem. Tomorrow, if allowed to grow, it can become a crisis."

Feuders handed warning . . .

. . . Oil Destroying Self

SAN FRANCISCO.—The oil industry seems bent on a process of self-destruction, H. S. M. Burns, president of Shell Oil Co., bluntly told the final session of the American Petroleum Institute.

He said this process of industrial fission is being fed by a series of internal reactions and through public ventilation of grudges between one segment of the industry and another.

Burns warned if this continues, the industry will be hoisted by its own petard and blown up by internal dissension. He added if the industry continues to wash its dirty linen in public and call for government intervention to solve every problem raised by competition, the oil industry will cease to exist.

The Shell executive admitted that many segments of the industry have complaints. Some are well founded and others not. They oppose actions of other segments over such things as imports, gas regulation, depletion allowance and jobber relationships.

Brawling kids . . . But Burns urged that every effort be made to settle such differences within the industry by the use of common sense and industrial statesmanship.

"I have been given to understand," he said, "that the Department of Justice gets more complaining letters and telegrams, urging action against one or another segment of the oil industry, than it does in respect of all other industries put together.

"The files of the department are, of course, not open to scrutiny. But I would be willing to bet that of these complaints nearly every one comes from within the industry itself."

Burns added this keeps things stirred up and makes the industry look like brawling school kids who deserve to be slapped down and regimented by uncle—"and by uncle I mean Uncle Sam."

H. S. M. BURNS
. . . "Why ain't you smart?"

All in same boat . . . He stressed repeatedly that every segment of the industry is dependent on the welfare of every other. He gave this example:

"If dealers turn against the depletion allowance for producers out of envy or revenge, less oil will be produced. It will cost more. And that will increase marketers' problems. If regulation of public utility gas service is extended to gas as a commodity and

Highway Committee Holds Meeting

These oil-industry leaders are members of the A.P.I.'s highway coordinating committee, which held an important session early last week. Standing, left to right, are P. C. Spencer, president of Sinclair Oil Corp.; T. S. Petersen, president of Standard Oil Co. of California; R. L. Minckler, president of General Petroleum Corp.; Frank M. Porter, A.P.I. president; John H. Bivins, director of the American Petroleum Industries Committee; Glenn E. Nielson, president of Husky Oil Co.; B. Brewster Jennings, chairman of the board of Socony Mobil Oil Co., Inc.; Robert H. Scholl, Esso Standard Oil Co., chairman of A.P.I.C. Seated: L. S. Wescoat, former president of Pure Oil Co. and chairman of this committee; M. J. Rathbone, president of Standard Oil Co. (N.J.); J. C. Donnell II, president of Ohio Oil Co.; Sidney A. Swensrud, chairman of the board of Gulf Oil Corp.; Frank O. Prior, president of Standard Oil Co. (Ind.); Reese H. Taylor, president of Union Oil Co. of California; and L. F. McCollum, president of Continental Oil Co.

to its production, the next step will be regulation of every aspect of the oil business."

He added: "Our continued ability to operate for the benefit of the country and of the people is threatened by the internal dissensions which I have mentioned."

Burns remarked even the "Hatfields and the McCoys . . . had enough sense to team up and present a united front when the 'revenooers' came around."

He concluded by asking the industry: "Since you are so rich, why ain't you smart?"

Demand Boom Seen

Nation may need 14 million barrels daily by 1965

SAN FRANCISCO.—Total U. S. demand for petroleum in 1956 will average 9,125,000 bbl. daily, the Chase Manhattan Bank estimates. This is an increase of 4.3 per cent over the average expected for this year.

The bank's estimates for next year and reports on its long-range studies of oil demand were given to the A.P.I. statistics committee by John G. Winger, petroleum economist for the bank.

The Oil and Gas Journal forecast a total U. S. demand of 9,020,000 bbl. daily for 1956. This is a gain of 349,000 bbl. daily or 4.0 per cent over 1955 (*The Oil and Gas Journal, November 14, page 118*).

Winger estimated the industry must produce a new supply approaching 9,190,000 bbl. daily for 1956, assuming a normal year-end enlargement of inventories. He refused to predict how much of this would be supplied by imports. But he said producers and importers will have a substantial increment of 400,000 bbl. per day to share.

The economist anticipated refinery runs averaging 7,865,000 bbl. daily during next year.

Turning to the long-range picture, Winger reported bank studies indicated a big gain in demand in the next decade. He forecast a 1965 demand for all oils in this country ranging between 13 million and 14.5 million barrels per day.

He recalled that all previous long-term forecasts for oil and all other industries made during this century have proved far short of actual developments. He said this suggests that forecasters should shake off some of their traditional conservatism.

Winger admitted that a 14 million barrel per day demand by 1965 may seem fantastic to some managements. He added his bank had made forecasts on several different bases and all of them fell within this range.

Porter tells the press . . .

. . . Better Selling Job Needed

SAN FRANCISCO.—The oil industry hasn't done a good job in selling itself.

Its public-relations program has made a lot of progress, but the industry still has a host of enemies and ignorance of the industry still abounds.

"We have to guard against talking to ourselves. Still, we have a lot of work to do in our own industry."

That's how A.P.I. President Frank Porter described one of the industry's current problems in a press conference.

On other subjects Porter had this to say:

. . . **Imports:** "The tension has eased . . . I don't think anybody wants regulation, when you come right down to it."

. . . **Harris bill:** "We're going to need all the help we can get . . . It's just something we've got to do."

. . . **Steel:** "Steel probably will be no problem. Inventories are pretty good, although there may be some supply-house shortages."

. . . **Drilling:** "We'll drill more footage in '56. I don't know about the number of wells."

. . . **Crude prices:** "I don't think a price increase would endanger the Harris bill."

Cold winter could mean trouble . . .

. . . Europe Poses Problem

SAN FRANCISCO. — Western Europe's booming demands are the greatest challenge to the international petroleum industry.

Its soaring demand for fuel oil is bound to affect the fuel-oil situation in the Western Hemisphere.

And, if the coming winter is a cold one, either here or in Europe, the oil industry may be "severely taxed" to make enough fuel oil to go around. T. L. Lenzen told a Division of Production session.

Lenzen, vice president of Standard Oil Co. of California, pointed out that Europe is enjoying an economic boom but said coal production is lagging behind in supplying the needed energy.

Where coal supplied 83 per cent of European energy in 1938, it now supplies 70 per cent and by 1975 will serve only 52 per cent of the market. Oil, Lenzen said, will move in to fill the gap.

The world outlook . . . Foreign free-world demand soon will match that of the United States, Lenzen said.

Ten years ago, use of oil in free-world areas abroad was only 40 per cent of its present 5,300,000 bbl. daily. Five years hence it is expected to be 7,500,000 bbl. daily, he said.

"Including the United States, it appears reasonable to expect that the daily petroleum consumption of the free world will increase from the present level of 13,000,000 bbl. to 17,000,000 to 18,000,000 bbl. in 5 years," Lenzen declared.

This great surge in demand, he added, will be due to expansion in transportation and industry and to an increasing per-capita use of oil.

Western Europe, whose gains are outstripping the rest of the world, is now supplied 80 per cent by Middle East oil. This figure will increase to at least 90 per cent within 5 years, Lenzen said.

European problem . . . Refiners in Europe are faced with the necessity of reorienting their yields.

Demand, Lenzen said, is shifting from an emphasis on light products to one on heavier fuel oils.

"European refiners which outfitted their plants after World War II in anticipation of continued light-product demand, now find their cat crackers not operating to capacity and their product-yield ratios out of balance with market requirements," he said.

Until now, prices have been determined on the basis that gasoline was the primary earner. "If the continuing trend is toward a lower yield of gasoline to crude and a simultaneous higher yield requirement for fuel oil, it may be expected that heavy-fuel-oil prices will strengthen," Lenzen declared.

R. L. MINCKLER

Just Good Manners

Divorcement of marketing wrong road, Minckler says

SAN FRANCISCO.—Divorcement of marketing from the rest of the industry will block—not promote—the steady flow of oil products to consumers.

"Everyone knows there is plenty of gasoline under our present system," R. L. Minckler, president of General Petroleum Corp., Los Angeles, told members of the A.P.I.'s Division of Marketing.

"There is plenty of competition under our present system. Divorcement will reduce that by denying the right to compete, but is that in the public interest?" Minckler asked.

Rather than this or other government interference, Minckler said better supplier-dealer relations could be brought about by the "practice of the homely virtues which always smooth out the rough spots in human relations."

These, he said, are understanding the problems of the other fellow, thoughtful consideration of his position, reconciliation or compromise of viewpoints, frank and open discussion, mutual helpfulness—all of which boil down to "good manners."

Getting Ready for the First Refining Session . . .

Lieut. Gen. James H. Doolittle, left, vice president of Shell Oil Co., New York, and Dr. J. E. Wallace Sterling, right, president of Stanford University, were the speakers at the first meeting of the Division of Refining on November 14. They are shown here with E. B. McConnel, vice president of Standard Oil Co. (Ohio) and A.P.I. vice president for refining.

Registration Workers Were Far Behind to Start

A crowd already was on hand to register when the first slips were passed out at the St. Francis Hotel. The St. Francis was headquarters for the Division of Refining and the Division of Marketing. Other divisions were headquartered in different hotels, with transportation in the Fairmont and production in the Sheraton Palace. This shot was made shortly after 10 a.m. Sunday.

Industry Role in NPC Praised

SAN FRANCISCO. — A two-fisted defense of the National Petroleum Council currently under political criticism in Washington, was made last week before a general session of the American Petroleum Institute. The defender was Walter S. Hallanan, president of Plymouth Oil Co. and chairman of the council.

Pointing out that NPC was organized at Government request to assist in formulating defense and other policies, Hallanan said:

"Through the National Petroleum Council, the industry has done the job. It is continuing to do it. Mindful that our continued existence as a free people is at stake, the council will resolutely hold to its fixed course regardless of unwarranted and unfounded political attack or inuendo.

"It will not be swerved from its patriotic duty by intimidation or threat in whatever guise they may appear."

Hallanan said the oil industry did the right thing in serving the Government through the NPC. But he added it now has a real obligation to let the American people know about this service. This is especially important, he explained, when some profess to see sinister purpose in the service.

"The industry should not hide its light under the proverbial bushel at any time. It should be the least immodest when that bushel is peppered by the bullets of falsehood and distortion.

"The oil industry has cooperated with Government because it is the right thing to do. There was a job to be done. The industry was asked by the Government to do it. It has done the job. It is as simple as that.

"The oil industry has more than measured up to the unusual demands of this complex age. It has been satisfied merely to hold the pace. It has moved out ahead to blaze a bright new trail in demonstrating that industry and Government can work together in the public interest without surrender by either of one iota of sovereignty."

The council chairman reported the record that has been made will stand careful scrutiny and critical appraisal. He predicted that public opinion eventually will approve the work that has been done.

"We are equally confident," he said, "of support of the industry's plan to carry on in this patriotic effort to give its best for the protection of our national defense and public welfare."

"Hot" Fuels Needed

More energy, less volume is required for jet age

SAN FRANCISCO.—American refiners have a challenge from the aviation industry to make an "unconventional" fuel with more energy per gallon.

Lt. Gen. James H. Doolittle told the A.P.I. Division of Refining this hotter fuel is needed to lighten loads of aircraft designed for higher speeds, higher altitudes and longer ranges.

The Shell Oil Co. vice president said strictly hydrocarbon fuels are rapidly becoming obsolete. Sheer weight of the fuel now in use is a limiting factor on both the carrying capacity and range of aircraft.

Higher energy fuels also would lighten the oil industry's task of providing tremendous volumes indicated by high fuel consumption of present and future aircraft.

Doolittle explained volume requirements will be very much less for certain specialized military tasks. The destructive power per aircraft now is so great that the same mission can be done with fewer planes than needed in World War II.

Without this trend, the tremendously increased quantity of fuel required for a typical mission with modern jets would be unbearable. Doolittle emphasized this by picturing these changes:

... **The old P-40** required about 200 gal. of fuel, weighing 1,200 lb., to make an 800-mile flight. An F-84 takes only half as long to make the trip but requires 760 gal. of fuel, weighing 4,800 lb.—four times as much.

... **A supersonic fighter** with a single engine and afterburner will consume fuel at a rate of over 20,000 lb. or 10 tons per hour. When multimotored fighters are considered, it is obvious that fuel requirements become a principal determinant.

... **The B-52** must carry at least 200,000 lb. or 30,000 gal. of fuel. This makes fuel weight and fuel volume per unit of energy one of our most important technical challenges in the future, he said.

Doolittle declared there never has been a question about the quality or availability of either high-octane or jet fuel. He praised the industry for a "monumental piece of work."

But the industry still can make a valuable contribution to national defense by coming up with a new fuel with more energy per pound and gallon at a reasonable price.

Division of Transportation:

MUNGER T. BALL
Sabine Towing Co.

LEE R. COWLES
Standard (Ind.)

JOHN W. de GROOT
Tuscarora Pipe Line

CLYDE F. DOWD
Tide Water (ret.)

CARL M. GOMPF
Ohio Oil Co.

Division of Production:

T. H. ACRES
Sunray Mid-Cont.

A. W. BREELAND
Lone Star Gas Co.

W. S. CRAKE
Shell Oil Co.

H. O. HILL
Bethlehem Steel Co.

J. R. MAHAN
National Supply Co.

A.P.I. Certificates of Appreciation

Division of Refining:

HOWARD G. VESPER
Standard of Calif.

INDIVIDUAL achievements shared the spotlight with industry gains and prospects at this year's meeting of the American Petroleum Institute.

Thirty-seven men were singled out for certificates of appreciation during the various A.P.I. sessions in San Francisco. Five of these were awarded posthumously.

The awards were a measure of formal A.P.I. recognition for outstanding contribution and tireless service—much of it voluntary—to the industry and the Institute.

The division of transportation led the list of award winners with 11 names on the 1955 honor roll. Seven others were cited for valuable service to the Oil Industry Information Committee. Seven certificates went to rep-

Safety Services:

J. L. RISINGER
Socony Mobil Oil Co.

R. B. ROAPER
Humble Oil & Ref.

W. N. YOUNG
Shell Oil Co.

Oil Industry Information Committee:

H. E. BRANDLI
Cities Service (Pa.)

A. B. GORMAN
Esso Standard

SAMUEL F. NINESS
Leaman Transportation

J. A. POLHEMUS, JR.
Standard of Calif.

DR. W. M. RUST, JR.
Humble Oil & Ref.

P. C. SPENCER
Sinclair Oil Corp.

CALVIN T. THOMAS
General Petroleum

Petroleum Reserves:

F. H. LAHEE
Sun Oil Co. (ret.)

THERON WASSON
Pure Oil Co.

Division of Marketing:

DAYTON P. CLARK
Gulf Oil Corp.

JOHN HARPER
Harper Oil Co.

Are Presented to 37 Industry Leaders

resentatives of production, while six men were honored for safety services, two for marketing, two for petroleum reserves work, and one each for achievement in refining, and finance and accounting.

Honored posthumously were Lot Bowen and F. M. Brewster, for their service in production; and R. W. Black, C. L. Hightower, and R. E. Donovan, for safety services.

Three other men received certificates of appreciation earlier in 1955. Two of them, A. E. Miller, Sinclair Refining Co., and E. L. Baldeschwieler, Esso Research & Engineering Co., got awards at the midyear meeting of the division of refining last May. The third, John Hammerman, Jr., Gulf Oil Corp., was honored at the safety committee's midyear meeting last April.

Financial and Accounting:

E. CHESTER PEET
Royal Dutch-Shell

W. H. BURNAP
Direct Service Oil Co.

C. HOUGHLAND
Direct Oil Co.'s

L. R. KAMPERMAN
Leonard Refineries

T. F. McGAREY
Cities Service

JOHN S. MORRISON
American Oil Co.

ROY M. STEPHENS
Humble Oil & Ref.

Refinery Mechanical Equipment Gets Attention

This group was caught hard at work early Sunday morning. It's the Division of Refining's subcommittee on mechanical equipment. Facing the camera around the table, left to right, are Harold Woodhouse, Dean Hill Pump Co., Indianapolis; W. D. Allison, Humble Oil & Refining Co., Houston; E. F. Voss, subcommittee chairman, Humble, Houston; R. S. Justiss, Gulf Oil Corp.; and T. P. Latimer, Clark Bros., Olean, N. Y.

Oil Men Rally to Fight

Porter warns A.P.I. control of gas prices is threat to all segments of industry, all must unite to put out the fire

SAN FRANCISCO.—Federal control of natural-gas prices at the wellhead is a fire that could burn through all divisions of the petroleum industry.

Frank M. Porter in his presidential address to the American Petroleum Institute declared all divisions of the oil industry must cooperate to fight the fire now.

Only a thin wall separates the burning house of the gas producer from the houses of other segments of the industry, and the walls are not made of fire clay or asbestos, he warned. Unless other divisions drop their immediate interests and join in putting out the flames, they will soon be engulfed in the spreading conflagration of federalization.

"Today, in this area of growing specialization within the industry, there are times when unity and cooperation seem rare," Porter said. "Many individuals in many segments seem to feel there is a danger in fighting a fire that burns a neighbor's house. Could there be any greater folly?

"Today one of the most vicious fires ever to burn in our land is threatening the independent producers of natural gas. We are face to face with absolute federalization of this segment of our industry.

"It is only a short step from federalization of the gas-producing industry to federalization of the oil-producing segment. It will be only another short step to federalization of the marketing segment.

"If we are realistic, the prospect of the Federal Power Commission occupying wellhead jurisdiction in the gas fields of this land is a danger which cannot be rationalized or compromised out of existence. If such should come to pass, the iron grip of nationalization will be fastened about the jugular vein of our entire industry.

Freedom lost . . . Porter declared as the lifeblood of free competition is squeezed from gas producers the gangrene of federalization will spread. Other parts of the industry soon will lose their freedom of competitive action which oil men have cherished for so long.

"Let's face it," he said, "whatever your product, whatever your position, whatever your other problems may be, once the federal Government begins to hold producing wells within its grasp no amount of refining, no amount of scrubbing, no amount of packaging or merchandising can free the remainder of the industry from that grip.

"If we are to be free, if we are to protect our rights of ownership, if we are to continue to do business in the American way, all of us—not just some of us—must make this fight against wellhead control over natural-gas production into our fight.

"No segment of the industry will make any real gain — short-term or long-term—from any temporary competitive advantage which federal controls might produce.

"In every crisis in the past the industry has produced the manpower and the unity of purpose to repel the attacker. We can do no less. We will do no less. If we make the good fight, we will attract to our banners those of like belief who will glory with us in the struggle. If we are craven, split assunder and disunited, we will deserve the awesome fate which most surely will be ours."

Capital Needs High

Prosperity based on high production, Humphrey says

SAN FRANCISCO. — Continued investment to expand capacity and continued research into new products and new uses for products were urged on the oil industry by George M. Humphrey, secretary of the Treasury, at the general session closing the A.P.I. meeting.

Prosperity cannot be handed down from the Government in Washington but must be built from the bottom up by high production, providing jobs for all, and encouraging everyone to save and invest in the future, he said.

Humphrey said that the most significant economic fact of recent years is that the United States has changed from a nation of have-nots to a nation of haves. Both business and government policies must now be based on this rather than on measures designed to avoid depression and crisis.

Inflation has been halted and most people now have savings which can be invested in the future growth of the economy. He urged oil and other industries to plan with this in mind by expanding capacity with confidence that consumer spending and private investment funds will remain high.

Recovery Trend Bright

Economics limiting use of new methods; result is stress on improving old techniques and better production practices

SAN FRANCISCO.—New oil recovery methods may appear sensational but they will not drive out the conventional techniques.

Thomas V. Moore of Esso Research & Engineering Co., New York, told an A.P.I. group session that new methods being developed undoubtedly will add to the recoverable oil reserves in many fields. But he declared conventional processes are also being improved to play an even more important role in producing the oil left behind by primary recovery.

Moore admitted some types of fields will not yield a large fraction of the oil in place with present-day practices. These fields are those which produce heavy, viscous oil and where the oil is held in tight reservoir rock.

Significant physical changes in the reservoir fluids are needed to get at this residual oil. Thus it is in these fields—and not on a universally applied basis—where new methods can be used to best advantage.

However, the newer techniques—petroleum solvents, several thermal methods, and surface-acting agents—must operate under an economic handicap. It will be difficult for them to overcome this. They must pay out while operating on a reservoir rock which is lean in oil. The large part of the original store of oil can be produced at moderate cost by conventional methods.

Advancements in production technology also will provide excellent opportunities to increase oil recovery from newer fields where modern recovery methods are not being used.

Moore declared the developments needed include better methods for:

. . . **Determining the amount of oil** in the reservoir. This includes better methods of coring and core analysis, improved well-logging instruments, and new methods of well testing and analyzing well-test data.

. . . **Predicting the effect** of natural forces, such as water drive and gravity drainage. This will come from better methods of analyzing reservoir performance.

. . . **Analyzing fluid-injection operations.** This will develop from improved understanding of the effect of such factors as reservoir irregularities, injection rate, injection-well patterns, and sections most suitable for injection and production.

. . . **Determining the reservoir's configuration,** perhaps from well-test data, possibly by geophysical methods. It would permit wells to be located properly with respect to the structure and would result in more efficient patterns of fluid flow in the reservoir.

. . . **Well completion,** well repair, and well stimulation to provide the necessary mechanical tools for reservoir control.

Developments such as these, Moore stated, will extend the usefulness of present production methods so that economic recovery may more closely approach the limit set by the laws of fluid mechanics. They also will be useful to the engineer in his attempt to meet the challenge of capturing the remaining oil not available through conventional methods.

I.R.A.A. Opposes Crude Hike

SAN FRANCISCO.—Unanimous opposition to any increase in domestic crude prices now was registered last week at a meeting of the Independent Refiners Association of America.

New processing developments also came up for discussion. The organization representing 23 nonintegrated refiners, reelected M. H. Robineau, president of Frontier Refining Co., Denver, as its president.

Crude prices rated top billing at the meeting. The group declared that in the face of present economic circumstances, there is no justification for such a move.

It was felt that such a development would spell the doom of the independent refining segment of industry.

The I.R.A.A. also spoke up on its wishes to get in on more of the research and development work arising from use of radioisotopes.

Much of the current investigation in this and related fields is being done in cooperative programs between oil com-

Economic Processes Are Scrutinized

These men are members of the A.P.I.'s economic-processes study committee, which met Monday. Left to right are Thomas W. Phelps, assistant to the chairman of Socony Mobil Oil Co., Inc., New York; A. Jacobsen, chairman of Amerada Petroleum Corp.; Sidney A. Swensrud, board chairman of Gulf Oil Corp.; Robert G. Dunlop, vice president of Sun Oil Co.; John W. Boatwright, director of sales research, Standard Oil Co. (Ind.); and James J. Cosgrove, board chairman of Continental Oil Co. Swensrud is chairman of the committee.

Corridor Conversation Was at a Maximum

Small talk occupied these pipeliners as they waited for a committee meeting to get under way at the Fairmont Hotel. Left to right are Morgan Martin, of the Houston pipeline division of Gulf Refining Co.; Charles W. Hubbell, Phillips Petroleum Co., Bartlesville, vice chairman of the subcommittee on pipeline construction practices; and D. F. Purdy, Richfield Oil Corp., Los Angeles.

panies and various government agencies. I.R.A.A. member companies, through the association, plan to offer their services to this growing program in return for an insight into the trends in processing which might result.

They feel that, singly, they are not in a position to participate. But by pooling their technical know-how they could make a contribution to cooperative government-industry studies involving such fields as jet fuels, gas turbines, isotope usage, and radiation.

If the independent refiner is to keep abreast of new developments and remain in a position to project plans for making fuels of the future, he must participate in the program and earn the right to this insight into what is coming, said I.R.A.A. spokesmen.

In view of the growing interest shown by nonmember independents, the association will tell its story to a number of companies across the country during the next several weeks.

Membership, which is not specifically revealed, includes companies operating throughout the central part of the country between California and the Eastern Seaboard.

O.I.I.C. gets new budget, new aim . . .

. . . No Mystery in Oil Business

SAN FRANCISCO.—The public relations program of the oil industry next year will tell oil's story to its own people.

More attention will be given to letting oil-company employes and managements know about the industry's accomplishments. Thus the better informed personnel will be more effective in their contacts with those who determine public reactions and policies.

Continued emphasis, however, will be placed on educational features of the school and film programs and advertising in national media which mould public opinion.

These and other features of the 1956 program were submitted by the Oil Industry Information Commission to directors of the A.P.I. here last week. The directors approved the program and a $3,195,000 budget, a slight increase over the current year's outlay. The O.I.I.C., headed by Adm. H. B. Miller, will have charge of the A.P.I. sponsored publicity campaign.

Where money goes . . . Advertising expenditures will total $919,000, a decrease of $100,000 compared to 1955. Some phases of the advertising and promotion including that devoted to telling the industry about itself will be increased.

In national advertising, magazines which are considered opinion leaders will be used. Less emphasis will be put on the mass circulation media. Approximately 75 per cent of the advertising budget will be spent with the general magazines, including Life, Time, Newsweek, U. S. News and World Report, Harpers, Atlantic, National Geographic, and Scholastic Magazine.

This advertising, in keeping with the general objectives of the program, will feature industry profiles. They will reflect the accomplishments of those who have contributed to the progress of the oil industry from its birth.

Other approved expenditures include $237,000 for the school program and $300,000 for film work. It is felt that these activities have been particularly effective in recent years.

Sweat and tears . . . The general objective of the industry's program is to "remove the veil of mystery from the oil industry." This was the pitch given by H. S. M. Burns, chairman of the A.P.I. public-relations committee, in opening the group session devoted to the work and plans of O.I.I.C. Burns is president of Shell Oil Co.

The public only hears about the successes of the oil industry through the public press and other media, Burns said. He emphasized that the public knows too little about the hazards and the "drama, blood, sweat, and tears of the oil industry."

Several phases of industry public relations were expanded over the past year. Those in charge felt that it has been "its best year," W. R. Huber, retiring chairman of O.I.I.C., explained at the group session. Huber is director of public relations for Gulf Oil Corp. He has devoted a large part of his time to O.I.I.C. over the past year. He has been succeeded by Richard Rollins of Atlantic Refining Co.

On outlining the work of this year, Huber said that 10 million people had seen the motion pictures prepared by the committee. Volunteer work on the part of the industry has been expanded until 30,000 participate in the work.

In the 1954-1955 school year approximately 2½ million pieces of material were distributed to secondary schools. Aids for teachers and students' booklets concerned with the oil business were in use at over 7,000 schools by the end of August.

Participation by the industry and its customers in Oil Progress Week in October exceeded that of any similar week in the past by a wide margin, Huber said. He explained that more and more women's organizations are being contacted, and during the first 7 months of this year 809 programs were presented to 45,000 women.

Personnel Training Was a Pleasant Subject

These four men were first arrivals at a meeting of the Division of Transportation's committee on personnel training. From the left are John Woodruff, University of Texas, Austin; Joe Meehan, Pure Transportation Co., Chicago; Russell Brannon, Humble Pipe Line Co., Houston; and Charles Curry, Sohio Pipe Line Co., St. Louis.

Vesper Gets Recognition

Howard G. Vesper, left, received a certificate of appreciation from the A.P.I.'s Division of Refining at the San Francisco meeting. The award is being presented by Robert E. Wilson, chairman of the board of Standard Oil Co. (Ind.) Vesper is a vice president of Standard Oil Co. of California.

Change of attitude needed to keep . . .

. . . Business Men in Government

SAN FRANCISCO. — Industry does have the ability to dispel the legend that business men cannot be trusted in Government.

There are four things that can be done, T. S. Petersen, president of Standard Oil Co. of California, told the American Petroleum Industries Committee.

He deplored the idea that business men are second-class citizens and are less patriotic than people of other professions. This concept dates back to the administration of President Grant and has been perpetuated by politicians for their own partisan ends, he said.

What business men can do about this immediately, Petersen said, is:

. . . **Make sure the public** knows the facts about business—and particularly big business—which it doesn't seem to know now.

Surveys of public opinion show that many of the antagonistic attitudes stem from almost complete lack of understanding of the character of business.

. . . **Portray today's business man** as he actually is and wipe out the old stereotype of a ruthless privateer.

The public should be made to realize that management is not synonymous with ownership, and that today's business man is a hired professional manager.

. . . **Encourage young executives** to develop some skill in public service.

One way to do this is to permit executives to take leaves of absence for government service without losing seniority with their companies and without sacrifice in salary.

It should be made acceptable practice for such a man to accept supplemental pay from industry so long as his government job does not concern his company's dealings with the Government.

. . . **Demonstrate the contributions** that business men can make to government service. In spite of criticism, inconvenience, and political attack, business men must serve in government posts and show by doing so that their management skills are of value.

Ultimately, said Petersen, this country will have to develop a set of "ground rules" for the conduct of people in public office. He pointed out that the British assume that a business man in government is to be trusted until he proves otherwise, but in this country the public mind seems to be conditioned to expect that a business man will do something wrong.

Plenty of Work Left

Oil industry still needs new equipment standards

SAN FRANCISCO.—There's a busy future ahead for the A.P.I.'s committee on standardization.

Problems of offshore drilling, ever-deeper drilling, dual completions, slim-hole drilling, automatic control—they all mean that new standards for equipment will be required.

This is what John R. Suman, Houston consultant, told a Production Division group session after it honored him with a certificate of appreciation for his "many years of leadership" in the A.P.I.'s standardization program.

Suman outlined just a few current industry needs resulting from trends in the industry as:

. . . **Drill pipe** which is more satisfactory for depths between 15,000 and 20,000 ft.

. . . **Wellhead equipment,** including valves and fittings, of a radically new nature which can safely handle pressures well in excess of 10,000 psi.

. . . **Tubing** adequate to handle abnormal pressures being encountered in many areas.

. . . **Casing programs** which will permit drilling to 20,000 ft. and below with a workable-size bore hole. In all probability, Suman said, this will require changes in the A.P.I. list of casing sizes.

Frontier Pushed Back

Gulf drilling record wildcat 50 miles offshore, erects platform for second test; Calco plans venture nearby

NEW ORLEANS.—Gulf Refining Co. has moved the frontier of offshore oil operations nearly 50 miles from shore to establish a new seaward drilling record.

Without fanfare, the company started drilling its first test in Block 253, West Cameron area. The test is on a 5,000-acre tract southeast of Cameron, La. It is about 48 miles from shore and 20 miles seaward from nearest production.

Shell Oil Co., which owns a lease on adjoining Block 252, will split the cost of the venture. Projected to 12,000 ft., the remote wildcat was below 7,600 ft. last week. Water at the well site is about 85 ft. deep.

Meanwhile, seagoing operators revealed plans for two other tests between 40 and 50 miles off the Louisiana coast:

...Gulf has erected a platform in Block 180, Vermilion area, another federal tract just short of the 50-mile limit. The first test, to be spudded within a few days, will be in the south half of a 10,000-acre tract for which the company paid bonuses totaling more than $1,100,000 last fall. Location is in water about 90 ft. deep.

...The California Co. is designing a platform to be erected in Block 160, East Cameron area, about 43 miles from shore. It will be about 20 miles east and slightly south of Gulf's wildcat in Block 252. The Calco well, due to be spudded in 4 to 6 months, will be in 80 ft. of water.

Platforms and tenders will be used at all three locations.

Each of the wells will be a few miles farther from shore than the present record-holder, which is a Phillips Petroleum Co. test in Block 184, Eugene Island area. This test, now below 13,000 ft., is about 40 miles from land *(The Oil and Gas Journal, August 8, page 69)*.

Although the farthest seaward of any tests yet announced in the Louisiana area, the new wells will be much nearer shore than the distant wildcat to be spudded in the near future off the Texas coast. This test, to be drilled by Shell and Continental Oil Co., will be 63 miles southeast of Galveston in Block A-104, High Island area.

The tract on which The California Co. will drill is one of the most expensive offshore blocks ever leased from the federal Government. The company

paid bonuses totaling $9,554,550 for the 5,000-acre block in the Government's last offshore lease sale in July.

The 5,000-acre block being tested by Gulf was leased in October 1954. Gulf paid a $4,003,000 bonus for Block 253 and Shell paid $2,600,000 for Block 252, a 5,000-acre tract adjoining it on the east. Shell also has a 5,000-acre lease just northeast of the site.

Deepest Drills On

Record well hits 21,766 ft. and bit bores ahead

PORT SULPHUR, La.—Richardson & Bass' big steam Rig 25 continued to churn away in the Mississippi delta marshes late last week, setting a new world's drilling-depth record with every turn of the bit.

Drilling was suspended for about 24 hours November 15 while an electric log was run. The bit was back on bottom early November 16 with total depth of 21,703 ft. in shale streaked with sand and next day reached 21,766 ft.

This is 284 ft. below previous depth record set in November 1953 by Ohio Oil Co. with a well in Paloma field, Kern County, California.

The well, 1 LL&E Humble "L," is being drilled about 35 miles southeast of New Orleans and about 3 miles east of nearest oil production at Lake Washington field. In the venture, along with Richardson & Bass, of Fort Worth, Tex., are John Mecom, Houston independent, and Freeport Sulphur Co., Houston.

Processing Briefs

BAYONNE, N. J.—A new ethylene recovery plant will be constructed soon at the Bayway refinery of Esso Standard Oil Co. The equipment will be the first on the East Coast to supply concentrated ethylene for the chemical industry. Ethylene processing heretofore has been concentrated in the Gulf Coast refining district.

DES PLAINES, Ill.—Universal Oil Products Co. last week announced two improved reforming catalysts designed specifically for production of gasolines of 98 leaded octane number and higher.

U.O.P. says the two new catalysts give increased gasoline yields, more hydrogen, and less carbon than reforming catalysts in use today. The new catalysts are spherical, but smaller in size than present catalysts. They are known as Type R-7 and Type R-8. The latter will have a higher platinum content.

MERAUX, La.—Southwestern Engineering Co., of Los Angeles, has been awarded a contract to build a 3,000-bbl. Platformer at Ingram Oil & Refining Co.'s refinery here. The Platformer will cost about $1,000,000 and will be designed to permit ready addition of a Rexformer.

CALGARY.—Royalite Oil Co. officially opened its new 5,000-bbl. refinery at Kamloops, B. C. The plant has a 1,425-bbl. daily fluid cat cracker and a 100-bbl. catalytic polymerization unit. It will process Royalite's own crude from Redwater field.

SCOTTSBLUFF, Neb.—Nebraska's first Platformer has gone on stream at Cooperative Refinery Association's plant here. The 650-bbl. daily unit was designed, engineered, and licensed by Universal Oil Products Co. The association will place another Platformer on stream later.

PANAMA CITY, Fla. — American Oil Co. has broken ground here for a new asphalt terminal which will have an initial storage capacity of 150,000 bbl. It will receive tanker shipments from Amoco refineries and will serve contractors in Northwestern Florida and Georgia by truck and tank car.

RICHMOND, Calif. — Standard Oil Co. of California will put its multimillion-dollar isophthalic-acid plant on stream here before the end of the year. The new plant, first of its kind in the world, will produce 50,000 lb. of the chemical yearly.

Experts Square Off For Depletion Battle

Bertram F. Linz

WASHINGTON. — The perennial controversy over percentage depletion is about to come front and center again.

The Treasury will disclose within the next few weeks whether it will make a fight next year to have the allowance reduced or repealed. Secretary Humphrey also is due to send his tax program to the House ways and means committee as it starts to write a new revenue bill.

Before then, however, the joint economic committee will make its own study and lay the results before the tax group. A tax-policy subcommittee will open a 2-week hearing December 5 on depletion and other issues. Witnesses will come from the 85 members of 17 panels set up last spring to study those subjects.

The panels were set up to get conflicting points of view. The group on depletion included four business men and three educators. Papers prepared by them in advance of the hearings were released by the subcommittee last week without comment. The business members urged that the present provision should be retained. The university members argued it should be repealed.

The panelists' papers covered the whole field of special tax treatment for the natural-resources industries. But they were directed chiefly to the question of depletion as an incentive to the discovery and production of oil and gas.

The defense . . . Scott C. Lambert of Standard Oil Co. of California, defending depletion, argued if the allowance was overly generous the effects should show in excessive profits of the industry, overdiscovery and development of reserves, and possibly overproduction. These have not occurred, he pointed out.

On the other hand, depletion has enabled the industry to develop the excess producibility required by the national-defense interest.

If the allowance was repealed, domestic crude prices would have to rise to compensate operators. But it is unlikely there also would be an increase in prices abroad. As a result, he said, the higher domestic price could not be maintained since foreign crudes would flood the market.

The opposition . . . Horace M. Gray of the University of Illinois charged that depletion was a subsidiary or "private tax-escape device." It may cost the Treasury as much as $750,000,000 a year in revenue from the oil and gas industry alone.

"On the other hand, the public benefits derived from this tax concession to the owners of natural resources are indeterminate and extremely dubious," Gray said.

Gray suggested that normal profit incentives and a free-price system should suffice to insure the adequate supplies which depletion is supposed to encourage. But if a subsidy actually is necessary on account of national defense requirements, some selective form or direct public assistance should be provided.

Gray questioned whether the risks of the natural resource industries are greater or more onerous than those of business generally. If they are, they should be compensated for by a higher return on capital "as determined in a free market."

Merits of allowance . . . Lowell Stanley of Monterey Oil Co. said that without the depletion allowance most operators would be forced by the tax laws to sell their properties outright, take their capital gains at the lower rate and leave operations to new purchasers.

Even with the allowance, many properties actually are worth more in anyone else's hands than the original owner, discoverer, and developer, he said.

"Statutory depletion provides income-tax recognition for wasting assets and recognizes the disposition of capital in the extractive processes," Stanley explained.

Boost for exploration . . . Arnold C. Harberger of the University of Chicago admitted there is good reason to suppose that tax incentives have substantially affected the amount of oil exploration. But he questioned their value in the case of other minerals.

Every effort should be made to place the tax treatment of these industries on a par with that of other industries, Harberger said.

He would do this by gradual reduction and eventual elimination of percentage depletion, leaving strict cost depletion as the sole basis for recovery of capital values. And he would reduce, and finally eliminate, the differences between the tax treatment of capital gains and ordinary income by raising the capital gains rate.

Element of luck . . . Arthur A. Smith of the First National Bank in Dallas held there is no reason to believe that the repeal of precentage depletion would eliminate the extremes of wealth in the oil industry. They are largely based on the element of luck, he commented.

Without depletion and the capital-gains provision, the inducement to explore for oil would be so reduced because of the extra hazards that reserves would fall and oil prices increase, Smith said.

Oil is the only major industry where at least three-fifths of every dollar of sales must be reinvested to find and develop new assets to replace those depleted, he pointed out.

No rewark for risk? . . . James R. Nelson of Amherst College cited the profit experience of 24 companies to support his contention that depletion "is not a reward for the special risks assumed by large oil companies, because there are no such risks."

Nelson asserted that the extractive industries exhaust resources. Therefore special tax stimuli inducing them to expand output are particularly undesirable on security grounds.

For petroleum, the security problem involves balancing support of a relatively high-cost domestic industry against the difficulty of storing imports and the geographically unfortunate location of some major import sources.

Somber note . . . Henry B. Fernald of Loomis, Suffern & Fernald, New York, warned of the consequences that will follow any material change in depletion or other tax incentives. He said it cannot be assumed that the extractive industries will continue the same in their own output and income, the employment they give and the purchases they make.

"The exact effect of any such changes may not be readily determinable, but must assume that, if material, they will have their material results," Fernald said. "The business incentive for investment and effort is the expected net return after taxes. If incentive is reduced, we must expect reduction in activity and resulting income. Assumption that with decreased depletion allowances the same activity will continue and greater taxes result is unwarranted."

"Taxes may impair, but do not create, the hope that future profits will be sufficient to warrant the uncertainties and risks of present outlays and effort."

Wilshire Sells Out

Malco is buyer, plans to import crude for refinery

ROSWELL, N. M.—Malco Refineries, Inc., has purchased properties of Wilshire Oil Co., Inc., including a 24,000-bbl. daily refinery at Norwalk, Calif. Sale price wasn't disclosed.

Robert O. Anderson, president of Malco, announced plans for a $3,000,000 to $4,000,000 modernization at the Norwalk plant to raise gasoline octane.

He said more than half the crude charged to the refinery would be from foreign sources, probably the Middle East. But he said he was interested in Italy, the East Indies, and South America, too.

"We're not going to be very popular with domestic producers," Anderson added candidly.

The oil man also disclosed plans for:

. . . A $1,000,000 marine terminal at Huntington Beach, Calif.

. . . A 130-mile products pipeline from Artesia, N. M., to El Paso, Tex., to cost $1,500,000.

. . . Entering the foreign field later, perhaps by building a refinery in Turkey.

. . . Possibly buying a fleet of tankers to transport foreign crude to the West Coast.

Along with the Norwalk refinery, Malco acquired some 85 miles of crude and products lines in California and also Wilshire's marketing setup. The Norwalk products will continue to be marketed under the Wilshire name. C. R. Blyth is president of the purchased company.

Malco has oil production in New Mexico and three refineries in the state—at Artesia, 10,000 bbl. daily; Bloomfield, 1,000 bbl. daily; and Prewitt, 2,500 bbl. daily. Malco and Wilshire had been negotiating for a year.

Treco Sold to Vitro

TULSA.—Vitro Corp. of America, New York, has acquired Refinery Engineering Co. of Tulsa (Treco) and its Canadian affiliate, Refinery Engineering, Ltd., of Toronto. The price was reported between $2 and $3 million including a substantial transfer of Vitro common stock.

Treco was organized in 1942 to contract for engineering and construction of oil refineries. It later extended its activities to natural gasoline and petroleum byproduct chemical plants. Vitro is a diversified industrial organization engaged in technologies associated with nuclear energy.

Good prospect stirs hope of . . .

. . . Cambrian Trend Extension

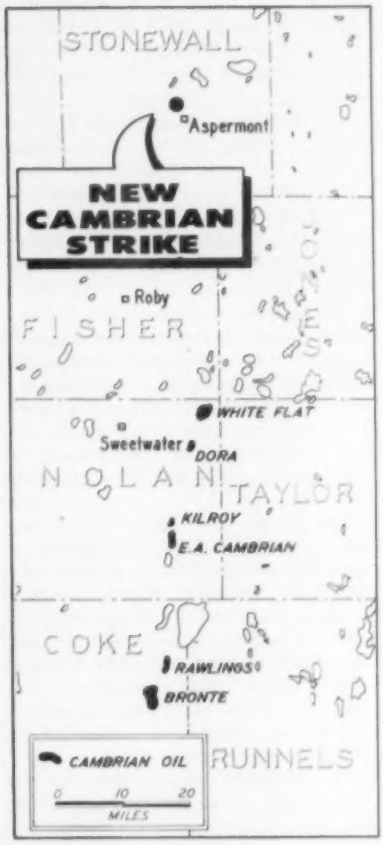
SWEETWATER, Tex. — Interest of West Central Texas operators turned again toward the so-called Cambrian Trend fields last week. A Stonewall County wildcat, 50 miles from nearest Cambrian production, developed oil in Cambrian sand.

This trend of Cambrian producers, which had a good play during 1952-54, stretches north from Bronte field in Coke County to White Flat field in northeastern Nolan County.

The new prospect, ready for attempted completion, is American Liberty Oil Co. 2 Shadle. Location is 2 miles north of Aspermont. Nearest production is the new Schick pool, ½ mile north, which produces from the Pennsylvanian Bend conglomerate. At present there is no Cambrian production in Stonewall County.

American Liberty's well found a 5-ft. Cambrian sand section, by samples, starting at 6,098 ft. A drill-stem test from 6,098-6,113 ft. indicated heavy production. The testing tool, open 15 minutes, had a flow of gas in 7 minutes and recovered 2,320 ft. of free oil in the pipe. No water was recovered. Gravity of the oil was 40.2°. Flowing pressure ranged from 375-675 psi., and 15-minute shut-in pressure reached 2,630 psi.

As in several of the other Cambrian fields, American Liberty's discovery found the Ellenburger section missing. It had shows of oil in other formations. One show was logged in the Strawn at 5,389-5,422 ft. The Bend section, from which Shick pool produces, was also missing. The Mississippian was topped at 6,050 ft.



Industry Briefs

HOUSTON.—Shell Pipe Line Corp. will purchase all of Humble Pipe Line Co.'s trunk line and gathering facilities in New Mexico. The transaction will become effective December 31. It involves 49 miles of 8-in. trunk line and 85 miles of gathering lines ranging in diameter from 2 to 8 in. Sale price was not disclosed.

TULSA.—A 10-story, $2 million office building is planned here to house employes of Shell Oil Co. and Shell Pipe Line Corp. Sunflower Corp. of Tulsa will own and operate the structure overlooking Boulder Park.

BURBANK, Calif.—Crestmont Oil Co. has bought out C.K.M. Oil Co. for an undisclosed price said to include cash and a note covering payout from future production. The purchase ups Crestmont's net proven reserves, after royalties, by 1,900,000 bbl., giving the firm a new total of 5,595,750 bbl. The newly acquired property consists of 65 acres in Kern County's Fruitvale field.

PHLADELPHIA. — Sun Pipe Line Co. will replace its present 110-mile, 8-in. products line from Twin Oaks, Pa., to Newark with a 14-in. line. The new line will have a capacity of 83,000 bbl. daily. It will go into service about September 15, 1956.

DENVER.—Stockholders of Kinney-Costal Oil Co., Denver, will meet November 21 in Portland, Me., to consider transferring the firm's assets to Ohio Oil Co. The transfer was discussed November 7, but no action taken. Kinney-Costal proposes to exchange 17½ shares of its stock for one share of Ohio stock *(The Oil and Gas Journal, October 17, page 87).*

Record Bonus Paid

Submerged Louisiana tract brings over $10 million

BATON ROUGE.—A record-shattering bonus of more than $10,000,000 was accepted by the Louisiana Mineral Board last week for a 5,000-acre lease under Terrebonne Bay.

The record bid was made jointly by Stanolind Oil & Gas Co. and Placid Oil Co. for Block 121, South Timbalier area. It provides a bonus of $10,466,711.56 in addition to one-sixth royalty of any oil or gas produced.

Underlying part of the state's "inland waters," the tract is the most expensive submerged block ever leased by either a state or the federal Government along the Gulf Coast. The bonus also is believed to be the highest ever accepted by Louisiana for any oil and gas lease.

Unusually keen competition featured bidding for the highly sound block. Runners-up included The Texas Co. with a bid of $7,506,000 and Magnolia Petroleum Co., which offered $6,009,778. Their bids also included one-sixth royalty.

Previous high bid for an underwater tract was $7,660,111 paid by Humble Oil & Refining Co. last spring for 4,687 acres at the mouth of the Mississippi River *(The Oil and Gas Journal, May 23, page 94)*.

Last week's top bid averaged slightly more than $2,093 an acre, several hundred dollars below the previous per-acre record.

In all, last week's sale brought $17,383,634 in bonuses.

New Catalyst Available

LOS ANGELES.—A new series of tailored cracking catalysts showing high resistance to metal poisoning is now in production by Filtrol Corp.

The new line can be tailored to refiners' specific needs, with alumina content ranging up to 90 per cent.

It is available in the form of closely sized microspheres for fluid units and as high-hardness pellets for all types of moving-bed processes.

Filtrol reports that the moderately priced catalyst combines extra high yields of gasoline and other distillates, lowered coke production, and low catalyst losses.

These performance records are based on results obtained from both pilot-plant runs and operations in full-scale commercial units. The new Filtrol offering represents the trend toward tailored catalysts which will meet the many varying needs dictated by type of charge stock and conversion levels.

WATCHING WASHINGTON

Bertram F. Linz

Distillate: The Coming Fuel

If the cold war winds up in an emergency, say 10 years from now, gasoline rationing may not be necessary. But there may be a whale of a shortage of fuels in the distillate range.

L. L. Colbert, president of Chrysler Corp., didn't say that when he talked recently before the National Press Club. But it was hinted at in his remarks about the gas-turbine automobile engine and in other prospective developments.

Colbert disclosed that a turbine-driven Plymouth is running around Detroit right now. A lot of problems must be solved before mass production is attempted, but he predicted the day is coming when the gas turbine will replace the present motor.

While the car manufacturers are looking to this new engine, the aviation industry is looking to the jet plane. By 1959 at least one company will have a fleet of turbo-jets in service. And the military, of course, is going in for the burner-type plane in a big way.

The railroads are dieselized and the diesel engine is coming into steadily greater use in trucks and buses. But the Defense Department, which would like to convert military vehicles to diesel operation, is approaching the shift cautiously. Officials frankly are worried about wartime fuel supply because of these growing demands for distillates.

How Big Is Too Big?

The old question, How big is too big? has been revived in Washington.

A Senate judiciary subcommittee is studying the question, with General Motors as its first target. The probe is headed by Sen. Joseph C. O'Mahoney of Wyoming. Sixteen years ago O'Mahoney headed the Temporary National Economic Committee study of the concentration of economic power which wound up with a pile of reports 41 in. high.

Frequent references to the oil industry during the General Motors hearings suggest the scope of the inquiry may be broadened if it proves politically attractive in a campaign year.

The main aims of the study are whether the present size and scope of G.M., and inferentially other big companies, are the result of superior efficiency and competitive skill; whether the great power associated with size and scope carries with it the opportunity for abuse; and whether, even without abuse, the very size of the organization makes competition impossible.

Some studious witnesses have said yes to all three questions. Some have raised the old charge that big corporations stifle new inventions.

Which System Is Best?

Russia is pulling ahead of the United States in the training of technical and scientific personnel.

Recent government studies indicate that unless we step up the effort we will fall steadily behind. There is more industry in the United States than in Russia. There are more colleges in the United States. But there are perhaps 300,000 to 400,000 fewer students studying for technical and scientific work.

It isn't difficult to spot the reason why Russia is pulling ahead in this field. Here, the student has a choice of careers. He may be fitted in all ways for research work, but he doesn't have to go into it. In Russia, a student who shows promise is "directed" into the field and cannot refuse gracefully—or safely.

Prices Also Go Down

Not all the rate applications filed with the Federal Power Commission by independent natural-gas producers call for price increases. There is a small but steady trickle of requests for reductions.

These rate cuts represent the effect of an escalator clause that works both ways. On one side it provides that the price paid for gas by a pipeline will increase to the amount that production or severance taxes are raised. On the other side it calls for a reduction in price if those taxes are decreased.

The price cuts aren't very impressive compared to the increases that are being asked. But if champions of consumers are right—if a few cents increase will cost them $800,000,000 a year, these reductions also should save them some millions.

ODM Wants Details

Flemming sets November 30 deadline for imports data

WASHINGTON.—Defense Mobilizer Arthur S. Flemming last week asked oil importers to report in detail by November 30 their October import figures.

Thereafter, Flemming told the importers, they will be expected to submit monthly reports by the fifteenth of each month, showing to what extent voluntary import cutbacks are being carried out.

Flemming's action followed an October 29 request calling for a 7 per cent voluntary cut in imports from all areas but Canada and Venezuela.

Report forms were sent to some 50 companies known by ODM to be importing oil. But Flemming said some companies which import only occasionally might not be on the list. He asked such companies to report voluntarily.

The companies are to show their imports of crude, residual, and unfinished oils for the preceding month, and to estimate their monthly imports for the succeeding 5 months. Flemming promised the figures would not be made public.

He said figures on both actual and planned imports are needed to see how closely importers are conforming with Cabinet Fuels Committee recommendations.

Deepest Producer

Shell's Louisiana well flows from 17,558-84 ft.

NEW ORLEANS.—Louisiana, which set a new drilling-depth record 12 days ago, now has the world's deepest well which is now producing.

The record breaker is a gas-condensate well drilled by Shell Oil Co. in Weeks Island field, Iberia Parish. Production is from 17,558-84 ft.

The producing zone is 30 ft. below that of the previous record holder, Humble Oil & Refining Co.'s 2 Rita Provost-Minvielle. The Humble well, also in Weeks Island field, produces gas and condensate from 17,530-54 ft.

Shell's new well, the 1 Claudia B. Patout and others, was bottomed at 17,725 ft. It is a stepout on the north flank of the Weeks Island salt dome, about 2,000 ft. from the nearest previous production.

The well flowed at a rate of 77 bbl. of 40.5°-gravity condensate and 2,901,000 cu. ft. of gas per day through a 5/32-in. choke. Tubing pressure was 4,800 psi.

Although establishing the world's deepest current production, the Shell test lacked 311 ft. of becoming the deepest producer in history. That record was set in 1953 by Richfield Oil Corp.'s 67-29 C.L.A. in North Coles Levee field near Bakersfield, Calif. The Richfield well flowed briefly from 17,500-17,895 ft. but is no longer producing.

Butte Pipeline Completed

BUTTE, Mont.—Butte Pipeline Co. has completed its $18,000,000 crude-oil line from eastern Montana field to existing Wyoming facilities which move crude to refining centers at Chicago and Wood River, Ill.

The 452-mile line extends from Poplar, Mont., to a connection with Service Pipe Line at Fort Laramie, Wyo., and to the Platte Pipe Line at Guernsey, Wyo.

Butte is owned by Shell Oil Co., Murphy Corp., Placid Oil Co., and Northwestern Improvement Co., subsidiary of Northern Pacific Railroad. The line is being operated by Shell Pipe Line Corp.

Beginning with a 10-in. line in the East Poplar field in Montana, the system extends south, becoming 12-in. at Glendive and increasing to 16-in. as the route nears Baker, 100 miles north of the Montana-Wyoming border. Incorporated in it is the 12-in., 35-mile line from Cabin Creek to Glendive, formerly owned and operated by Shell Pipe Line.

Two pump stations under construction at Baker, Mont., and Osage, Wyo., will give the line an initial daily capacity of about 37,000 bbl. The line climbs uphill throughout the entire system, from 2,000 ft. above sea level to 5,100 ft.

City Votes to Drill

Redondo Beach approves pact with Signal group

REDONDO BEACH, Calif.—Voters last week approved two proposals for exploration of a quarter of this city's tidelands.

One calls for a contract between the city and Signal Oil & Gas Co.—acting as operator for itself, Reserve Oil & Gas Co., and Artnell Oil & Gas Co.—for exploration from restricted shore drilling sites. The other measure lifts a drilling ban in the area.

Under the contract, Signal must start drilling within 180 days. The area involved has a 4,000-ft. ocean frontage extending to the city's northern limits and seaward 3 miles.

Preliminary exploration calls for slant-drilling at least six wells from an onshore site. Wells must be drilled to at least 7,000 ft. and must bottom at least 330 ft. from shore.

Signal must post $100,000 bond against beach or water contamination, and may be fined $4,000 a day if pollution develops.

No lease provisions or lease rights are involved in the contract. Leasing in any form is denied Redondo Beach under the 1915 Tidelands Act, but a development contract is not. Contingent on production, the new pact will be in force 35 years.

Operators must guarantee the city at least $250,000 annually starting 5 years after successful completion of the first well. Royalties will be based on a sliding scale, starting at 18 per cent of the gross sales price and ranging up to 50 per cent. The operators must pay all exploration and production costs.

No. 6 Fuel Oil to Power Gas Turbines

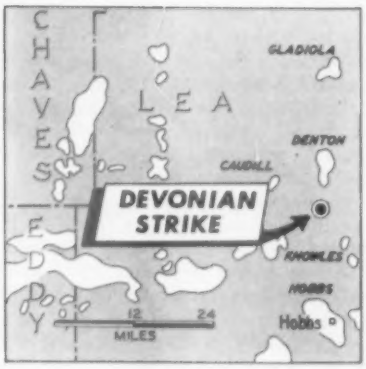
CHICAGO.—A new filtration method has whipped the corrosion problem blocking use of cheap No. 6 fuel oil in gas turbines.

The development was reported last week by General Electric Co. at the annual meeting of the American Society of Mechanical Engineers. The process, using a precoat cake of fine diatomaceous earth filter aid, was described by C. H. Shields, Jr., chemical engineer for G.E.

No. 6 fuel oil has been burned in turbines in the past. But its low cost was offset by rapid corrosion in the turbines. The new filter sharply reduces the impurities responsible. The chief villians have been sodium, vanadium, and calcium, which form a sticky and corrosive ash. All of the contaminants aren't from crude oil. Some originate in refinery processes and in sea water during shipment.

These corrosive elements were reduced substantially in laboratory tests. Sodium concentration was cut from 200 to 2 parts per million. The filter also eliminated a large portion of calcium, iron, aluminum, magnesium, sediment, and total ash.

The process in commercial practice will have a continuous rotary precoat filter. Chemists are experimenting to improve its efficiency and to find out whether it works with all types of No. 6 fuel oils.



New Pool for Lea

Potential of New Mexico well is 1,200 bbl. daily

HOBBS. — Another deep Devonian pool has been opened in the area of Caudill - Denton - Knowles fields in eastern Lea County, New Mexico. The oil find is Signal Oil & Gas Co. 1 Gulf-State, located in an area of intense exploration some 16 miles north of here.

Initial tests of the well have indicated a 146-ft. pay section and a daily flow potential of 1,200 bbl. of 48°-gravity oil.

The 1 Gulf-State drilled into the Devonian, by samples, at 13,017 ft., or minus 9,257 ft. First drill-stem test of the Devonian at 13,024-42 ft. did not flow, but unloaded oil after 77 stands of drill pipe had been pulled.

On test at 13,044-92 ft. oil flowed in 51 minutes at the rate of 20 bbl. an hour. Flowing pressure ranged from 1,140-1,538 psi. Thirty-minute shut-in pressure reached 5,195 psi.

Operators, convinced a better-than-average structure had been tapped, cored an additional pay section to 13,170 ft. They tested between 13,090-13,170 ft., getting the heavy flow of oil. The 1,200-bbl. a day rate was through ¾-in. choke. On ¼-in. choke the well flowed at the rate of 575 bbl. a day, under pressure of 500 psi., and with a gas-oil ratio of 1,320:1. There was no water with the oil. Additional coring is planned.

Gasoline Prices Raised

TULSA.—Continental Oil Co. last week raised gasoline prices half a cent a gallon in Oklahoma and New Mexico.

The increased applied to tank-wagon prices for both premium and regular in Oklahoma. It covered only premium in New Mexico.

Continental said the higher prices were required by the increasing cost of providing higher-quality fuel for modern, high-compression engines.

Amazing recovery claimed in . . .

. . . New Gas-Steam Heat Drive

HARRISON, N. J.—A new oil recovery method injecting hot gas, steam, and hot air as oxidizer for underground combustion has been developed by the Worthington Corp. with striking results.

Hellmuth Walter, director of research for Worthington, revealed the process brought 80 per cent recovery during a 2-year field test on a small tract in southeastern Illinois. He indicated the tests show that nearly 90 per cent recovery is possible. The pilot work was conducted in a 110-ft. sq. area.

Walter explained that 10 per cent of the oil content in formation was used up by underground combustion in the operation. The remaining 10 per cent was driven into the adjacent formation where it could be recovered in a large-scale operation.

The Worthington research chief claimed the new method should be highly profitable for operations covering 100 or more acres. He said present methods result in extracting only between 40 and 70 per cent of known oil reserves.

Walter declined to reveal full details of the process pending completion of design work on new equipment employed in the operation. But it is based on an idea being tested by many other companies. Heat introduced to the formation reduces viscosity of the heavy oil and drives it from the rock. In addition to heat furnished by the gases, some combustion of the oil occurs to aid the thermal drive.

The test was conducted by Worthington in cooperation with Forest Oil Corp. of Bradford, Pa., in a shallow field in southeastern Illinois. Worthington said the field was selected because it contained highly viscous oil previously considered unrecoverable by existing methods. The bottom temperature of the field was about 50° to 60° F. This was too low to allow the heavy oil to run freely or be driven out of formation.

Walter reported Worthington built special equipment for a pilot test plant. It allows the driving and reactive agents to be changed with varying geological conditions and viscosity of the crude. Hot combustion gases and steam were used as driving agents, he said, and hot air as oxidizer for underground combustion.

Recovery was made through four wells drilled in the corners of a 110-ft. square. Core tests revealed recovery of 80 per cent of the oil content, originally estimated at 24,000 bbl. per acre.

Walter predicted the new method and similar processes being tested by other companies would add several billion barrels of oil to the recoverable reserves of this country.

New partner in big venture . . .

. . . T.G.T. Joins Trans-Canada

OTTAWA. — Tennessee Gas Transmission Co., operator of the world's largest pipeline network, is becoming a partner in the $350,000,000 Trans-Canada project.

T.G.T. is expected to hold one-third interest in Trans-Canada Pipe Lines, Ltd. Original partners in the venture are Canadian Delhi Oil, Ltd., and Western Pipe Lines, Ltd.

The Trans-Canada management arrangement is to remain generally the same. But Tennessee Gas likely will be represented on the management committee. Terms of the deal and other details were not disclosed.

The move brings into Trans-Canada the company whose gas import-export plan holds the key to financing the entire 2,250-mile pipeline *(The Oil and Gas Journal, October 17, page 90)*. This plan is now before the Federal Power Commission.

T.G.T. has signed a contract with Trans-Canada to import 200,000,000 cu. ft. of natural gas daily at the Canadian border near Emerson, Man. An additional 200,000,000 cu. ft. would be imported when available. The gas would be sold at points along a proposed 1,112-mile line from Emerson to near Nashville, Tenn., planned by Midwestern Gas Transmission Co., a T.G.T. associate.

Tennessee Gas is to develop eastern Canada markets by selling Trans-Canada up to 86,755,000 cu. ft. of gas daily for delivery at the international boundary near Niagara Falls, N. Y.

Entry of T.G.T. into the Trans-Canada organization was made known as the dominion and Ontario governments worked toward clinching an agreement to set up a crown company to build the uneconomic portion of the line. That is the 675-mile stretch across northern Ontario which must be crossed to reach lucrative eastern markets.

Banking on imports cut . . .

. . . Texas Hikes Allowable

AUSTIN.—The Texas Railroad Commission last week hiked the Texas oil production allowable for December to 3,323,312 bbl. daily. That's 96,793 bbl. daily over the initial figure for November and 87,261 bbl. daily over the allowable as of November 5.

Commission action went against recommendations of most major crude-oil purchasers. It was based primarily on approaching colder weather and presumed future cuts in imports the rest of the year.

Only three purchasers—Atlantic Refining Co., Magnolia Petroleum Co., and Sun Oil Co.—favored the adopted 17-day producing schedule. Most recommended 16 days. Shell Oil Co. and Phillips Petroleum Co. both asked for 15. Either of the latter two schedules would have meant substantial cuts in oil output during December.

Why the increase . . . Commission Chairman William J. Murray called attention to a letter to importing companies from Arthur S. Flemming, defense mobilization director. It called for a 7 per cent cut in imports from all countries but Canada and Venezuela during the rest of 1955 and the first quarter of 1956 *(The Oil and Gas Journal, November 7, page 71).*

"There is no reason for me to suppose that these American importing companies will not comply with the statute enacted by the last session of Congress, particularly since Dr. Flemming has pointed out that they are impairing national security by continued violation," Murray said.

In view of these anticipated cuts, Murray said, "It is felt that Texas is entitled to increase its production by at least part of the requested import reduction."

Murray also pointed out that the industry is approaching the heaviest oil-consuming season of the year and that above-ground stocks of crude oil have been substantially reduced from the "excessive wasteful levels at which they stood earlier in the year."

Culberson's view . . . Olin Culberson also strongly supported the December increase.

Refineries east of California, he said, are operating at 92 per cent of capacity so far this year as compared with 83 per cent for the same period last year. Products stocks indicate a firm situation. Stocks of finished and unfinished gasoline are running only 348,000 bbl. higher than last year, kerosine 1,795,000 bbl. higher, and distillate fuel oils of all grades 15,266,000 bbl. higher.

Crude stocks, he said, are still well below the 260,000,000 to 270,000,000 bbl. indicated by companies themselves as the desirable level a year ago.

Wage Drive Begun

Substantial increases set as O.C.A.W.'s goal

KANSAS CITY.—Management representatives negotiating soon with the Oil, Chemical and Atomic Workers International Union, CIO, will be confronted with requests for substantial wage increases.

The union's 54-member bargaining policy committee decided here last week to make wage increases the key in future negotiations in the oil industry. The policy will cover more than 100,000 union oil workers across the nation, mostly in refineries with some in pipeline, oil field, and wholesale marketing classifications.

O. A. Knight, Denver, union president, said the union will present a united front on the wage issue and will present arguments to justify pay increases considerably larger than industry has been offering in the past.

The exact amount of increase sought was not determined by the policy committee. It was left to the discretion of individual locals to allow more flexibility in negotiating, Knight reported.

However, the bargaining committee statement indicated local units will be furnished a general wage formula to guide them in negotiations. No local unit may accept any wage offer without prior approval of the policy committee.

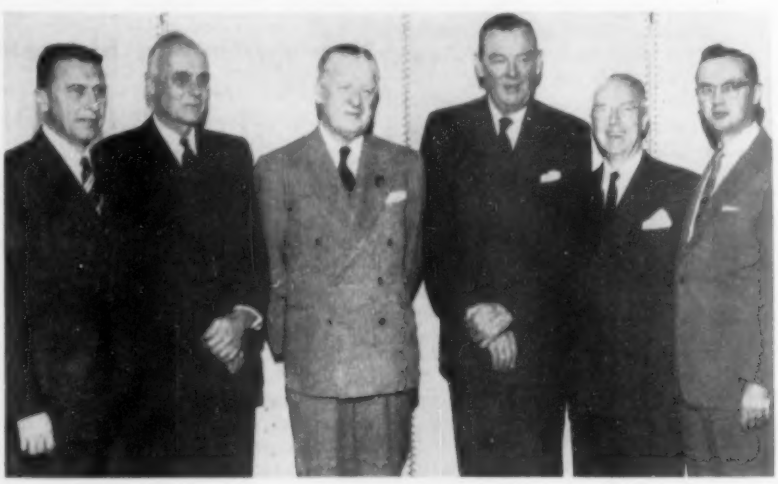
In addition to wage increases, the union program includes a move for upward adjustments of wage rates in many job classifications and improved fringe benefits.

Utility Selling Pipeline Stock

DENVER.—Public Service Co. of Colorado is offering its 15 per cent interest in Colorado Interstate Gas Co. to the public. Sale of the 256,000 shares, valued at about $14,000,000, is being handled by a syndicate and selling group.

The stock was acquired by Public Service in 1931 to help Colorado Interstate improve its reserves. The firm's total reserves now are 5.4 trillion cubic feet, enough to last 25 years at present consumption rates.

About 75 per cent of the natural gas distributed by the pipeline is purchased by Public Service.



A.P.I. Brass Gather for a Transportation Luncheon

This group was caught by the photographer just before a luncheon for speakers and officers of the A.P.I.'s Division of Transportation. From left to right are George H. Hill, Jr., vice president of Cities Service Co., Inc., New York, and vice chairman of the transportation general committee; B. Brewster Jennings, chairman of the board of Socony Mobil Oil Co., Inc., New York and A.P.I. treasurer; P. C. Spencer, president of Sinclair Oil Corp., New York and retiring A.P.I. board chairman; Charles S. Jones, president of Richfield Oil Corp., Los Angeles, and A.P.I. vice president for transportation; James E. Dyer, president of Sinclair Refining Co., New York, and A.P.I. director; and Charles E. Spahr, executive vice president of Standard Oil Co. (Ohio), and secretary of the general committee on transportation.

Italy Claims New Strike

Government monopoly reports third discovery, gets ready to start production while Petrosud wells remain shut-in

Paul Swain

ITALY'S state-controlled oil company last week claimed another oil discovery near Pescara on the Adriatic coast as political debate over the country's new oil law continues to rage.

Last week's was the third such claim in the past 2 months made by Ente Nazionale Idrocarburi. The government said last week the latest well, Madonna della Croce No. 1, encountered an oil formation at about 1,960 ft. and is drilling ahead to its projected depth of 4,500 ft.

The well is being drilled by Somincen Co., an affiliate of the state-controlled E.N.I. It is less than 1 mile from Vallecupa 1, completed in September after encountering oil sands at about 1,600 ft. Somincen is already drilling two more wells in the Vallecupa vicinity and will drill a stepout to the latest discovery.

E.N.I. announced last week it now has three contract seismic parties at work in the Abruzzi region of the Adriatic coast where it has other exploration acreage.

Oil activity in Italy for the past year indicates the country could become the first nation in Western Europe to be self sufficient in petroleum with the proper development of her potential. Just how that development will be carried out is the hitch. The Mussolini-fostered idea of "Italy's oil strictly for and by Italy" is still strong. Enrico Mattei, head of E.N.I., has encouraged this sentiment. Yet it has remained for private enterprise and foreign capital to show the way.

The law, its implications . . . The political tug-of-war over who should develop Italy's oil has been going on for years.

It's not over yet. The bill revising legislation approved by Premier Antonio Segni's cabinet is certainly not gladdening the hearts of international oil companies. It calls for a 60-40 split of oil profits, with the Italian Government getting the big end.

If such a law is passed, no international company will look for Italy's oil and develop what it finds. To do so would mean an automatic revision of every agreement with every other country in the world where those companies now operate on a 50-50 basis.

Every international company except one has watched Italy with an interested but wary eye. The present law governing oil exploration and production is obviously outmoded. It offers a foreign investor very little assurance he can profit from his search for oil.

What happened to Gulf . . . Gulf Oil Corp., the one exception, took the plunge. Petrosud, S.A., a joint operation of Gulf and Montecatini, has drilled two wells on an exploration concession on the Adriatic Coast. Gulf's theory was that if it showed its faith in the Italian Government, the government would reciprocate. Gulf's first well flowed more than 2,000 bbl. daily of 34°-gravity oil on initial tests. The second well is just as good.

So far, the Italian Government has failed to reciprocate. Both wells are still shut in and the government has refused to grant a development concession.

The first of the E.N.I. discoveries claimed in September is less than 2 miles from Cogno 1, Petrosud's first well, and is only a stone's throw from the Petrosud concession. While Petrosud's wells are still shut in, E.N.I. has been awarded a temporary permit to produce 14,740 bbl. of crude from its first well, 1 Vallecupa. The permit was issued less than a month after Guido Cortese, Italy's minister of industry and commerce, said E.N.I. had not filed a production application and did not intend to file one.

Critics of the government's refusal to issue Petrosud a production permit say the action has cost Italy more than $4 million which could have been saved on crude imports if the wells had been allowed to produce. They also say the government is actually violating the 1927 mining law, which is still valid, by denying Petrosud permission to produce its wells.

The "tough" provisions of the proposed law are regarded mainly as political trading material for use on the floor of the Italian Parliament. Few observers believe the Italian Government has any intention of trying to stick with the 60-40 profit split provision.

Next Week:

. . . Abadan's Return

Due to the comprehensive coverage of the A.P.I. meeting in this issue of the Journal, the third in a series of articles on Iran is being delayed until the November 28 issue. In next week's Journal, International Editor Paul Swain will trace the steps taken during the past year to bring the world's biggest refinery back on stream.

Bolivia Boosted

McCarthy wants to build crude line and refinery

GLENN McCARTHY, Houston, revealed plans last week for possible construction of a 450-mile pipeline and 3,000-bbl. refinery to serve as an outlet for his company's Bolivian oil production.

The crude line would extend from the Gran Chaco area of Bolivia to Concepcion, Paraguay, where the refinery would be built.

Glenn McCarthy, Inc., obtained a 970,000-acre exploration concession in the Gran Chaco area in 1953. Since then four wells, including two oil wells and a gasser, have been drilled there.

Further development has been delayed by lack of a production outlet and by financial difficulties. To ease the money strain, the company recently sold half interest in the concession for $2,000,000 to a syndicate headed by Keljikan Commercial Corp., New York *(The Oil and Gas Journal, August 8, page 80)*.

McCarthy returned to the United States in search of the necessary financial backing for construction of the refinery and pipeline. Cost estimates were not disclosed.

Mexican Pipeline Planned

A 22-in., 130-mile natural-gas pipeline is planned by Gas Industrial de Monterrey, S.A., from Reynosa to Monterrey in northern Mexico.

The project will parallel the company's 14-in. line which has been supplying Monterrey since 1947. Gas Industrial is soliciting bids from American companies on the new job.

Texas Eastern Transmission Corp. recently completed a deal with Petroleos Mexicanos, the government monopoly, to buy 100 to 200 million cubic feet daily of gas from the new absorption plant at Reynosa *(The Oil and Gas Journal, October 3, page 98)*.

Refinery for Cuba

Texaco ready to start on 20,000-bbl. daily plant

THE TEXAS CO. will start building a 20,000-bbl. daily refinery at Santiago de Cuba this month.

The $14 million refinery will go on stream early in 1957. It will be built on a 400-acre site on the west side of a deep water harbor about 3 miles south of Santiago de Cuba.

Cia. Petrolera Shell de Cuba started work on a 25,000-bbl. daily refinery on Havana Bay—at the opposite end of the island of Cuba—several months ago. The Shell refinery is expected to be on stream in late 1956.

Texaco has been marketing fuel oil and lubricants in Cuba for nearly 40 years and recently expanded its marketing activities to include gasoline and diesel fuels. Cuban consumption last year was about 56,000 bbl. of products daily. The country's refining capacity is now about 10,000 bbl. daily.

The new refinery will be built for The Texas Co. (West Indies), Ltd., a wholly owned subsidiary of Texaco. Construction will be under the direction of the parent company's refining department. The units will include a 20,000-bbl. daily crude distillation unit, a 3,300-bbl. daily cat reformer, a 4,100-bbl. daily hydrotreating unit, and a gasoline-sweetening unit.

About half the refinery's output will be fuel oil, one-fourth kerosine and diesel oils, and the remainder gasoline.

Guatemala Popular

Some 30 companies seeking acreage under new oil law

GUATEMALA Government representatives said last week that nearly 30 companies, majors and independents, plan to seek exploration concessions in Guatemala.

Anyone interested in entering the country under the terms of the new petroleum law is almost certain to apply before 6 p.m. November 23. All applications for acreage received up to that time are given equal priority.

Julio Asino-Wunderlich, minister-counselor of the Guatemalan embassy in Washington, said last week that nearly 30 companies are expected to file. If that many do seek acreage, conflicting applications will be more numerous than those in Libya *(The Oil and Gas Journal, October 3, page 97)*.

For 15 days after that November 23 deadline, the Guatemalan Government will pass on the eligibility of applying companies. The law provides they must "demonstrate financial capacity and technical aptitude."

After this initial 15-day period, companies with conflicting applications face another 15-day wait while the government sets hearings to resolve the conflicts. The hearings last another 15 days. The government can require bids to settle remaining conflicts or direct that companies involved trade tracts.

Elmer Batzell, Washington petroleum consultant to the Guatemalan Government, said last week it may take until March to decide some concessions. Batzell estimated that $25 million to $30 million will be spent in exploring Guatemala.

Most companies agree that Guatemala exploration is going to be expensive. The most promising region is the Province of Peten, about the northern one-third of the country. It's rugged country with no roads.

Just west of Peten across the British Honduras border, British Honduras Gulf Oil Co., a wholly owned subsidiary of Gulf Oil Corp., is drilling a wildcat after 2 years of seismic work. Gulf last week was drilling below 6,000 ft.

Creole Maps Budget

Haight reports spending in '56 will top $180 million

CREOLE PETROLEUM CORP. plans to spend at least $180 million expanding its Venezuelan operations during 1956.

The $180 million figure, disclosed in Caracas last week by Harold W. Haight, Creole president, is regarded as conservative. It could go as high as $200 million. The current plans compare with Creole expenditures of an estimated $120 million on 1955 expansion.

Creole, a subsidiary of Standard Oil Co. (N.J.), was included in the $1,200,000,000 which the Jersey Standard companies will spend in 1956 for capital investment and expenditures *(The Oil and Gas Journal, November 14, page 133)*.

Haight said the increased budget for Creole is necessary to pay for the company's industrial expansion projects in Venezuela. Among projects already under way are:

... **A second gas injection plant** on Lake Maracaibo expected to be completed in 1957 at a cost of $36 million.

... **Development of a new tanker port** in Eastern Venezuela at the inland city of Maturin in Monagas.

... **Expansion of the La Salina terminal** in Lake Maracaibo to handle Creole production for the entire area.

... **Expansion of Amuay refinery** slated for completion in 1956 at a cost of $11 million.

Wildcat Planned

Union will spud fourth test in Costa Rica soon

UNION OIL CO.'S Cie. Petrolera de Costa Rica will spud in its fourth wildcat in Costa Rica within 30 days.

It will be located about 13 km. northwest of the firm's present 1 Bris now being drilled 35 km. from Puerto Viejo. The new venture will be the 1 Cocoles.

Drilling at the 1 Bris has passed 6,500 ft. Reports have circulated that the 1 Bris will be abandoned soon. If so, it will be the third dry hole Union has drilled in this area in the past year.

The 1 Cocoles will be located in dense tropical jungle. The area was completely unexplored until Union geologists penetrated the section. Work on access roads to the well has been slowed because natives fear the deadly jungle snakes and animals.

Richard Harris, director of international operations for Union, reports the company is considering another exploratory well farther north near the port of Limon on the Caribbean coast.

Harris also denied reports that Union is pulling out of Peru following seven dry holes drilled on the coastal area. He said the company has taken concessions totaling 1 million hectares in eastern Peru and is even retaining some of its coastal concessions.

International Briefs

The trade agreement which has existed between Brazil and Venezuela for the past 15 years was extended another year last week. The trade balance between the two countries has been heavily in Venezuela's favor because of shipments of crude and refined products to Brazil.

The Indian Government will spend 85 million rupees ($17,850,000) on a 5-year oil exploration program in a 5,000-sq.-mile area near Jaisalmar. The exploratory effort will be confined to the one area in northwestern India along Pakistan's eastern border, but may expand to other areas later.

Creole Petroleum Corp. has reduced posted prices for two Venezuelan crudes and increased the base of the gravity scale for a third. Creole cut its posting for Mulata crude of 36.0°-36.9° by 8 cents a barrel to $2.82 and its price for Oficina crude, 35.0°-35.9°, by the same amount to $2.80. The base of Creole's Guanipa crude's gravity scale was increased 1° to 31.0°-31.9° at a price of $2.55.

special section

Fig. 1—Corrosion test probe.

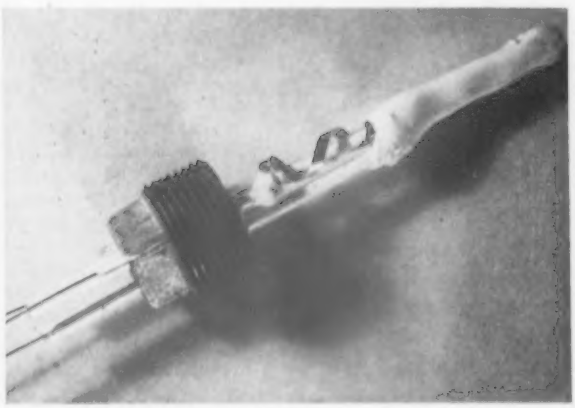


Fig. 2—Bridge corrosion meter.

Here's Pure's New Corrosion Meter

Here is a two-part article on a new corrosion meter developed by the research and development laboratories of Pure Oil Co., Crystal Lake, Ill. Part 1 is an exclusive article on how the meter works, and was submitted to the Journal by the authors. Part 2 gives an example of how the meter is used. This article explains the use of the new meter in measuring tanker corrosion rates. It is a paper presented at the annual A.P.I. meeting in San Francisco, November 1955, under the original title, "Corrosion Rates in a Tanker."

1. Here's how the meter works . . .

by G. A. Marsh and E. Schaschl
Pure Oil Co.

A NEW probe for corrosion testing has been developed. This is a simple temperature-compensated device which makes use of the change of electrical resistance during corrosion to determine loss in metal thickness. The probe is small enough to fit into a half-inch hole in a vessel.

Any metal can be tested that can be produced in wire, thin ribbon, or foil form. A modified Wheatstone bridge permits the corrosion of the probe to be measured directly in microinches loss of metal thickness without removing the probe from its environment.

Measurement of corrosion loss can be made continuously on a meter or recorded. The method has been applied to numerous laboratory and field problems.

Some of the features of the probe and measuring instruments are the subject of applications in the U. S. Patent Office.

Improved method . . . An electrical-resistance method has been used for a number of years for studying corrosion.[1,2,3,4] It has not been too widely accepted as a laboratory or field technique because of the need for close temperature control during the resistance-measuring operation. The resistivity of steel changes by 10 per cent between 85° and 100° F. In making plant tests where the temperature is unknown or variable, the resistance method has previously been limited to "before and after" measurements.

The new apparatus eliminates the effect of temperature, so that the resistance method can be applied to continuous recording of corrosion in any corrosive environment.

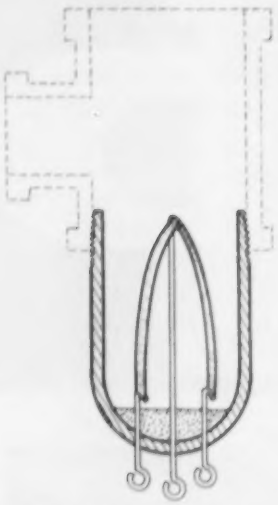


Fig. 3—Probe design for high-pressure testing.

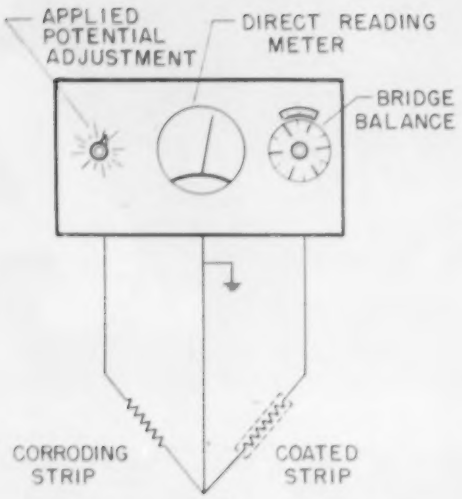


Fig. 4—Probe installed in a bull plug for high-pressure tests.

Description of Probes

The problem of temperature compensation was solved by using steel strips as two arms of a Wheatstone bridge. Since the strips have the same temperature coefficient, the effect of temperature on the resistance of the steel arms of the bridge is eliminated. Furthermore, junction potentials and thermoelectric effects which normally plague the measurement of small resistances are canceled out in the Wheatstone bridge.

The corroding specimen is preferably a strip about 3 in. long, as shown in Fig. 1. One end of the corroding specimen is attached to a "protected" specimen, which has the same size and shape as the corroding specimen, but which is insulated from the corrosive liquid. For convenience the protected and corroding specimens can be parts of a single strip of metal.

A connection is made at the junction between the corroding and protected parts, and also at the opposite ends of these parts. All the junctions are soldered or otherwise firmly made and then coated with a protective material. The coating is also applied to the protected part of the metal strip.

The soldered area is kept as small as possible and accounts for only about 5 per cent of the area of the probe. (As this area is not available for corrosion, a small error is introduced which can be corrected for if desired.)

Coating . . . The coating used for the most part so far has been a thermosetting epoxy resin. This is resistant to most corrosive solutions as well as to most organic solvents. For more severe conditions the coating could be polyethylene, Kel-F, or Teflon, or Sauereisen cement.

The corrosion-testing units, or probes, can be adapted to go through a hole of ½-in. diameter or larger. For laboratory testing it was found convenient to mount the probes on rubber or cork stoppers which could be inserted into bottles containing the corrosive solution.

For field work, probes have been mounted on bull plugs or pipe plugs, and on the ends of long ferrules which can be lubricated into a vessel under pressure.

Fig. 2 shows a high-temperature type of probe in which silver solder is used rather than lead solder. Also, the coating on the protected specimen is Sauereisen cement which is a ceramic material. Fig. 3 illustrates a probe mounted in a bull plug, which permitted a study of corrosion inside a vessel at several hundred pounds per square inch pressure. In these latter types the protected specimen was spiraled around the central contact wire to provide more mechanical strength.

Metal thickness . . . The thickness of metal used for the corroding specimen is chosen in such a way that there will be an appreciable fraction of metal lost through corrosion during the desired test period.

For example, if the desired test period is a day or less, the thickness may be 0.0005 or 0.001 in. If the desired test period is a week, the thickness may be 0.005 or 0.01 in. The latter figure is about the largest that can be used in the present design of the apparatus.

A conveniently manufactured probe (when steel is to be tested) can be made from shim stock. This material is under considerable internal stress and yields corrosion rates which are probably slightly higher than normal for steel. This circumstance provides a built-in safety factor.

If desired, the corrosion rate can be correlated with that of ordinary unstressed steel by vacuum annealing the shim stock as suggested by Dravnieks and Cataldi.[1] In our tests the results at room temperature were about the same when annealed and ordinary shim stock were used, but a difference would probably show up at higher temperatures.

Measuring Bridge

The corrosion measurements are conveniently made by means of the bridge device outlined in Fig. 4. This consists of a Wheatstone bridge, one arm of which is the corroding specimen and another arm of which is the protected specimen. The other two arms of the bridge are formed by an adjustable potentiometer. This is a panel-mounted control with a vernier dial to permit accurate resetting.

By means of this control, the bridge can be initially balanced, so that at the start of a test the ratio of the resistances of the corroding and protected specimens equals the ratio of the resistances on opposite sides of the potentiometer. This balance is indicated by a zero deflection of the meter.

Meter . . . The meter is a 0-100 microammeter in a special bridge circuit. By means of a switch, the metering circuit can be applied to measure either (1) the unbalance of the Wheatstone bridge (which occurs as a result of increased resistance of the corroding specimen) or (2) the potential across the protected specimen.

The meter is initially adjusted with a control so that a 20 per cent decrease in cross-sectional area of the corroding specimen corresponds to exactly 100 μa. deflection. For adjustment purposes it is convenient to substitute a long length of copper wire instead of the short pieces of shim stock.

A 10-ft. length of No. 20 copper wire has about the same resistance as a 3-in. length of 0.001 by 0.125 steel shim stock. A 25 per cent incremental resistance which is equivalent to the 20 per cent decrease in cross-sectional area is easily obtained by using a wire that is 25 per cent longer than 10 ft., that is, 12.5 ft.

With control adjusted so that a 25 per cent increase in resistance corresponds to 100 μa. deflection on the meter, it remains to find out what applied potential exists across the Wheatstone bridge under this condition. In other words the deflection of the meter depends on the applied potential to the Wheatstone bridge as well as the amount of unbalance in the bridge. It is not necessary to know the absolute value of potential applied to the bridge.

The special circuit can be simply switched to a "calibrate" function so that it measures the potential across the coated strip in arbitrary units. The applied potential can be reset to this value in all subsequent measurements. As a refinement, a separate control is incorporated which comes into operation when the meter is switched to "calibrate." By means of this control the applied potenital needed can be made to come out to some convenient figure, say 50 on the meter.

Bridge analysis . . . The applied potential needed to give a 100 μa. deflection with a given per cent change in resistance of the corroding specimen is independent of the initial resistance of the corroding specimen. This can be shown by a mathematical analysis of the Wheatstone bridge.

However, the theory was tested quite simply by substituting long copper wires of various gages, which had resistances of about half or double that used in the initial calibration. In each case, upon setting the applied potential to the proper value (i.e. 50 on our unit), an increment of 25 per cent in the resistance of one arm caused exactly 100 μa. deflection.

Short copper leads have a negligible resistance compared with that of steel probes. For some applications, however, it is desirable to use long leads. The effect of lead length is eliminated by simply running the applied potential leads out to the probe instead of to the balancing resistances of the Wheatstone bridge.

The resistances of the leads to the probe then become part of the other resistances of the bridge and are separated from the resistance of the probe. Furthermore, a separate wire is run out to the coated specimen, so that on "calibrate" position the circuit can measure the voltage between the coated specimen and ground without measuring the IR drop in any leads.

Testing probes . . . A large number of probes can be tested with the same bridge. Each probe is tagged with an identifying number followed by the vernier dial setting corresponding to initial balance with that particular probe.

The stability of the bridge is excellent; and since the device is built on bridge principles, it is reasonably immune to normal line voltage fluctuations. No precautions are needed against picking up stray currents, but it is necessary to make all connections between the bridge and the probes with low-resistance contacts.

While all the tests described here were carried out using manual readings, it would be possible to make a continuous recording of the decrease in metal thickness vs. time by using a millivolt range recording potentiometer in the meter circuit of the bridge. Such instrumentation would permit one to study the progress of corrosion continuously while it occurs and would be especially useful in cases where there are changes of corrosion rate with time.

Thermal compensation . . . A major contribution of this probe method is the elimination of the effect of temperature on the resistance of the corroding specimen. While from theory the use of the protected specimen should compensate for temperature changes, this feature was checked using several probes.

The probes were "balanced" at room temperature, i.e., the bridge was adjusted to give zero meter deflection. Then the probes were immersed in an oil bath at 210° F. There was in each case a slight shift off zero, just barely detectable.

Next the probes were corroded in dilute acid until they showed a deflection around 50 μa. They were then again immersed in the hot oil and again showed practically no deviation from the room temperature deflection. This set of experiments proved that the resistance of the corroding specimen is adequately temperature compensated.

Testing corrosion . . . The bridge is adjusted so that a 25 per cent increase in resistance of the corroding specimen is indicated as a 100-μa. deflection. As there is a reciprocal relationship between resistance and cross sectional area, this 100-μa. deflection indicates a 20 per cent decrease in average cross-sectional area, or a 10 per cent change in average thickness on each side of the specimen.

The edges of the specimen are small by comparison to the width and are neglected in this calculation. When using a 0.001 - in. - thick specimen, the 100μa. deflection corresponds to a corrosion loss of 0.0001 in., or 100μin. The meter reading therefore directly corresponds to the loss in metal thickness of one side of the corroding specimen, in microinches, for a 0.001-in. thick speci-

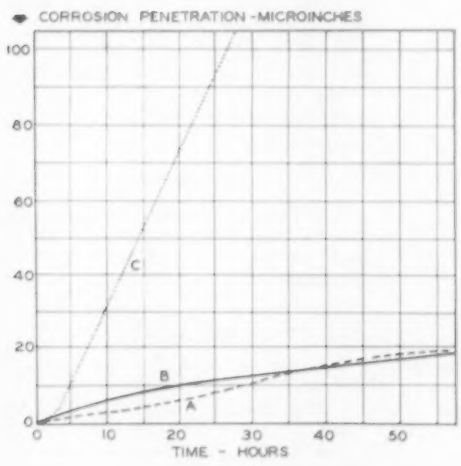


Fig. 5—Inhibitor X.

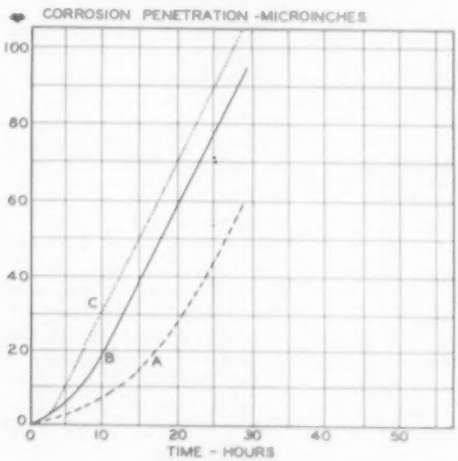


Fig. 6—Inhibitor Y.

Test A—Probe initially and periodically kept in gasoline phase. Test B—Probe initially and periodically kept in brine phase. Control, no inhibitor present. Corrosion of steel alternately immersed in gasoline and 3 per cent NaCl solution, room temperature.

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Glenn A. Marsh received a B.S. degree in chemistry from Illinois Institute of Technology in 1945 and a M.S. in chemistry from Northwestern University in 1946. He began his employment with Pure Oil Co. in 1948. He is engaged in corrosion research.

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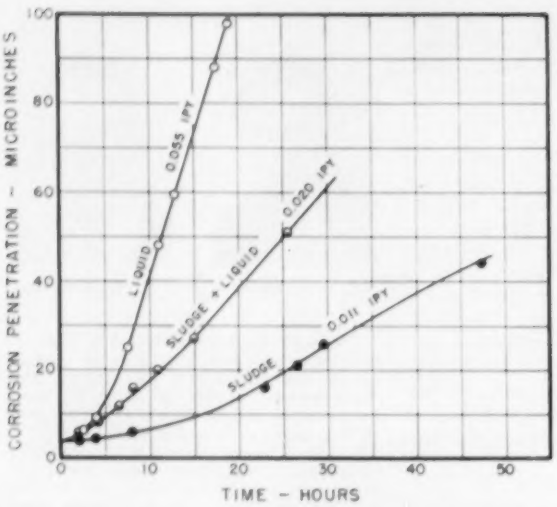

Fig. 7—Corrosion of steel in liquid and sludge taken from a crude-oil gathering system in the presence of 150-psi. H_2S at room temperature.

men. For thicker or thinner specimens, the meter reading

$$\times \frac{\text{original thickness of specimen}}{0.001 \text{ in.}} =$$

metal loss in microinches. The meter face can be provided with several scales to take care of different thicknesses of probes.

The meter reads directly in loss of metal regardless of the metal. To calculate corrosion rates from the meter data it is necessary to take readings over a period of time long enough to establish two points on the corrosion-time curve. The slope of the line, loss of metal thickness as a function of time, is the corrosion rate.

To obtain inches penetration per year it is necessary to multiply the slope in microinches per hour by 0.00875. For a 24-hour run, corrosion rates can be measured as low as 0.0002 in. per year. For an 8-hour run, the lowest measurable rate is about 0.0006 in. per year.

Average rates . . . In some plant tests or oil field tests, the average rate over a period of time is of more interest than the corrosion rate over a few hours interval. Here the thicker probes, 0.005 or 0.010 in., are preferred so that headings can be taken at weekly or bi-weekly intervals.

The advantages over weight loss testing in such cases are that (1) the installation needs to be made only once as it is not necessary to remove the probe at the end of the test, (2) the answer is obtained immediately, right on the spot, without chance for error in removing corrosion products, and (3) readings can be taken as often as desired to observe possible changes in corrosiveness.

The reproducibility of the probe method is such that the readings on different probes are almost always within 5 per cent of the average reading all the way to 100-μin. loss. In many cases duplicate probes were only 1 or 2 μin. apart at readings near 100. Over a thousand probes have now been used.

The correspondence with weight-loss testing has been checked and found to be close. Because of the fact that there is no way in which a meter deflection can be obtained by the probe method without having the corresponding loss in metal, the probe method is believed to be the more reliable than coupon testing.

Dravnieks and Cataldi, who recently studied the resistance method, pointed out that the results are not reliable if corrosion proceeds beyond 20 per cent of the total thickness of the corroding specimen, or if there is a high degree of localized attack such as pitting. However, these same limitations apply to conventional weight-loss testing.

Laboratory applications . . . Figs. 5 and 6 show the use of the probe method in testing gasoline rust inhibitors. In the test method the probe was exposed alternately to brine and gasoline. The dotted line in each case represents the control test with no inhibitor present. The solid and dashed lines represent two ways in which the test was carried out.

Inhibitor X, Fig. 5, was very effective in both tests, while Inhibitor Y, Fig. 6, was only partially effective in one test and practically had no effect in the other.

Fig. 7 shows the use of probes in testing corrosion of steel in liquid and sludge from an oil field gathering system pipeline. The pipe had been thinned due to internal corrosion at a low place in the line. The probes showed that an excessive corrosion rate was associated with water and sludge drawn from the pipe.

Other laboratory data have been obtained using the probes in testing inhibitors for special purposes, testing the corrosion rate of steel in pilot refinery units and other applications.

Other field applications . . . Probes have been used to determine the effectiveness of inhibitors in large oil-field emulsion treaters. The probes were inserted into the vessels by means of "lubricators" or blowcases installed in manhole covers. Using this method, one could tell by the slope of the corrosion-time curve if inhibitor injection was mitigating corrosion, without having to remove, clean, and weigh coupons.

An extensive survey was made at a refinery to establish the corrosion level in various plant streams and in blending and storage tanks.

Some tests on oil wells have been carried out, using the probes in place of coupon testing at wellhead.

Limitations and advantages . . . The main limitation of the probe method is also one of its valuable features; namely, its small size. In general, the larger the specimen, the more nearly will results approach actual field results.

However, in most cases, insertion of a large test panel is out of the question in a field installation, so that the probe provides a compromise. The correlation between probe data and large panel weight loss is being obtained in one installation but the results are not yet known.

The probe method has proved extremely useful in rapidly establishing the corrosion "level" of an installation. For comparison results, such as in classifying media according to their relative corrosivities, the probe method appears to be ideal, as it is rapid, simple, and reproducible.

So far most of the probes we have used have been simple expendable units. They are made in fifteen minutes by a technician with average manual dexterity. For plant installations, probes have been used which have a replaceable corroding strip. This type of probe takes about an hour to make initially but the corroding strip can be renewed in a few minutes, and the probe can be used any number of times.

The applicability to a recording unit is another advantage which has not yet been explored.

Acknowledgment

The bridge was designed by L. E. Ellison. Thanks are due Dr. D. C. Bond and Dr. K. M. Watson for their encouragement and interest in this work.

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2. Example—Use of meter to measure

Tanker Corrosion Rates

by G. A. Marsh and A. V. Koebley, Jr.

THESE results were obtained from corrosion tests on ship tanks during a round-trip tanker voyage from Beaumont, Tex., to Jacksonville, Fla.

1. An oil-soluble rust inhibitor reduces the corrosion rate of steel in gasoline to 15-20 per cent of the uninhibited rate. There is no carryover of inhibitor effectiveness when tanks are used for sea-water ballast or when they are washed with hot sea water.

2. Cathodic protection of ballast tanks, using magnesium anodes, reduces the corrosion rate to a low value.

3. Hot sea-water washing increases the corrosion rate about 15 times compared with unwashed tanks. This high rate of corrosion continues until the ship is again loaded.

4. Partial dehumidification of the air in the washed tanks has some beneficial effect but does not reduce the corrosion rate to a tolerable level.

Details concerning corrosion of the interior of cargo tankers have been discussed in several recent papers.[1,2,3] An excellent survey of present practices from the standpoint of tanker corrosion mitigation has been presented by F. M. Watkins.[4] While much information is available on corrosion rates, the data are mostly average rates over long time periods.

Determination of rates . . . Pure's new probes (see accompanying article) were left in place continuously except for periods of about 10 minutes when they were removed for measurement. Measurements were made at intervals from 1 to 8 hours, depending on the corrosion rate, and several probes were exposed to each set of conditions. To eliminate possible galvanic effects, the probes were insulated from the ship, except when cathodic protection was being studied.

The data were obtained in the unit of microinches penetration per hour, which has more significance for short exposures. The corrosion rates were then converted to inches per year for convenience in comparing with other data.

Accuracy and reproducibility . . . The relative corrosivity of different conditions is believed to be accurately represented by the data, which are for initially clean, bare steel. The accuracy of the data is about ±0.001 in. penetration per year based on clean steel with a somewhat greater tolerance if the results are applied to rusted steel.

The reproducibility in the present experiments was also about 0.001 in. per year. Experiments are planned to study further the effect of various rust films on the corrosion rates. The present data, while yielding a self-consistent comparison of corrosion rates, would no doubt be somewhat different under conditions where the test specimens were rusted prior to the experiments.

Experimental Conditions

The ship used for the experiments, the S.S. Pure Oil, and a T-3 tanker carrying mostly gasoline with a smaller amount of other products. The experiments started with the loading of the ship at the refinery near Beaumont.

Part of the gasoline cargo was discharged at Port Everglades, Fla., and the remainder was discharged at Jacksonville. The westward trip to Beaumont was made nonstop. The round-trip voyage took about 8 days. Average summertime gulf weather conditions prevailed.

Part of the gasoline and diesel-fuel cargoes carried a proprietary oil-soluble rust inhibitor at a concentration of 8 lb. per thousand barrels of product. These products are designated "inhibited" on the figures.

Center tanks carrying sea-water ballast are cathodically protected with sixty-eight 50-lb. magnesium anodes which are intended to give a current density of 30 ma. per sq. ft. By using grounded and ungrounded probes in these tanks, an attempt was made to study the effect of cathodic protection.

Dehumidification . . . The ship was also equipped with a dehumidification system by means of which a slight pressure of relatively dry air could be maintained on desired empty tanks. At the time of the tests, the dry air was employed in about 70 per cent of the vessel's cubic space. The unit's output was approximately 1,500 cu. ft. per minute, at a dew-point depression of 30° F.

Normally, hot sea-water washing is not done on this ship to any great extent. For these tests, however, certain tanks were "Butterworthed" ½ hour with sea water at 180° F. The probes were left in the tanks during the washing operation.

A summary of combinations of conditions tested is given in Table 1 which also lists the corresponding figure number. Corrosion-rate data are given in Table 2.

Diesel fuel was practically noncorrosive even without inhibitor. The kero-

Authors are with Pure Oil Co., Chicago. Paper presented at annual meeting of A.P.I., San Francisco, November 1955, under the original title, "Corrosion Rates in a Tanker."

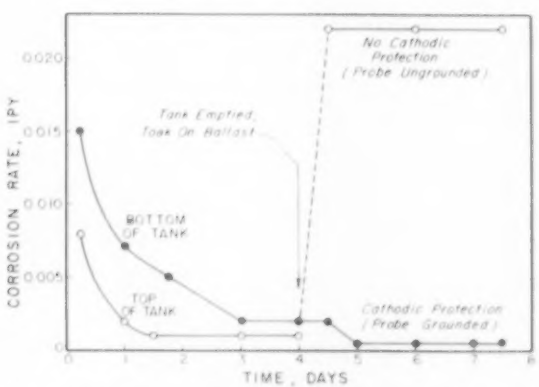

Fig. 1—Tank 2C, gasoline with inhibitor followed by sea-water ballast.

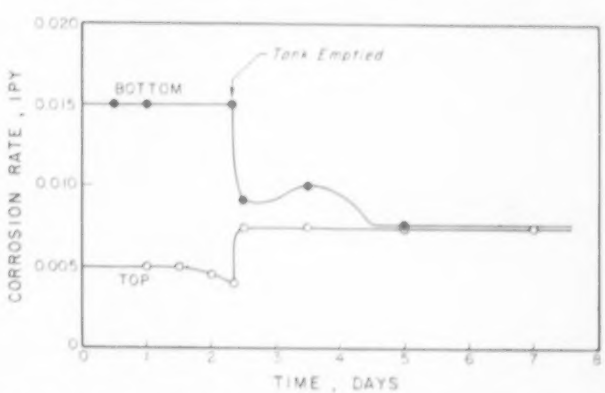

Fig. 2—Tank 1C, gasoline without inhibitor. No dehumidification or wash.

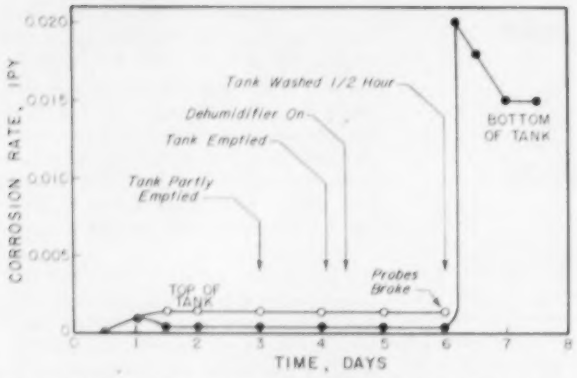

Fig. 3—Tank 4C, diesel fuel without inhibitor. Tank washed and dehumidified.

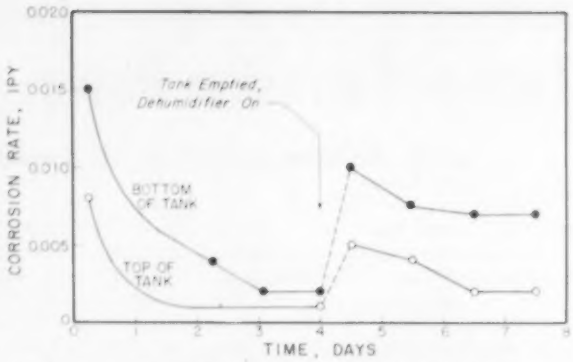

Fig. 4—Tank 6C, gasoline with inhibitor followed by dehumidification. (Data of first 4 days obtained in tank 2C.)

sine and gasoline, however, were moderately corrosive. Inhibitor in the gasoline reduced the corrosion rate to about 20 per cent of the uninhibited rate. An adsorption period of 1.5 to 3 days was required before the inhibitor became fully effective.

The high rate of corrosion in uninhibited gasoline is confirmed by reports in the literature as well as by service experience on this ship. However, experience shows that the tops of the tanks corrode faster than the bottoms over a long period of time, while in the tests reported here the reverse was consistently found (Figs. 1 and 2).

TABLE 3—CORROSION RATES IN SEA WATER BALLAST TANKS

No.	Product previously carried in tank—	Corrosion rate, in./yr.— With cath. protection	Without cath. protection
1.	Gasoline + inhibitor	0.0005	0.022
2.	Kerosine, no inhibitor	0.0005	0.025

Sea Water Ballast Tanks

Corrosion rates for sea water ballast tanks are shown in Table 2 and Figs. 1 and 5. Grounded probes, subjected to cathodic protection from magnesium anodes, showed a low rate of corrosion, while ungrounded probes gave very high readings. The probes were pretreated for 1-2 days by immersion in product with and without inhibitor, but the inhibitor pretreatment did not have any beneficial effect. The effect of inhibitor, at least on fairly clean steel, is apparently lost once the tank is loaded with ballast.

One of the two ballast tanks tested had new magnesium anodes, while the other had anodes which were two-thirds spent.

The ungrounded probes, with no

TABLE 1—KEY TO COMBINATIONS OF CONDITIONS TESTED

Product—	Tank	Inhibitor in product	Sea-water ballast	Hot sea water washed	Dehumidified	Fig. No.
Gasoline	2C	Yes	Yes	No	No	1
Gasoline	1C	No	No	No	No	2
Diesel fuel	4C	No	No	Yes	Yes	3
Gasoline	6C	Yes	No	No	Yes	4
Kerosine	5C	No	Yes	No	No	5
Diesel fuel	4S	Yes	No	Yes	No	6
Diesel fuel	4P	Yes	No	Yes	Yes	7
Stoddard	5P	No	No	Yes	No	8

TABLE 2—CORROSION RATES IN TANKS CARRYING PRODUCTS

Product—	Corrosion rate, inch penetration per year
1. Gasoline + inhibitor	0.001-0.002
2. Gasoline, no inhibitor	0.005-0.015
3. Kerosine, no inhibitor	0.007-0.010
4. Diesel fuel + inhibitor	0-0.001
5. Diesel fuel, no inhibitor	0.0005-0.0015

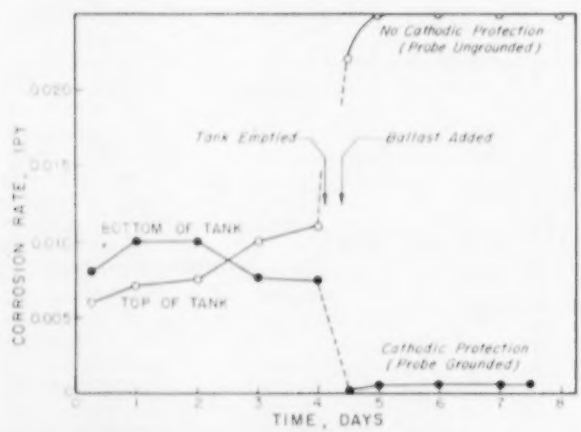

Fig. 5—Tank 5C, kerosine without inhibitor followed by sea-water ballast.

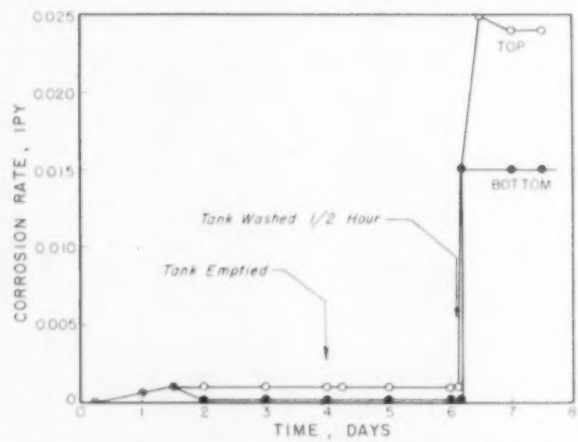

Fig. 6—Tank 4S, diesel fuel with inhibitor. Tank washed but not dehumidified.

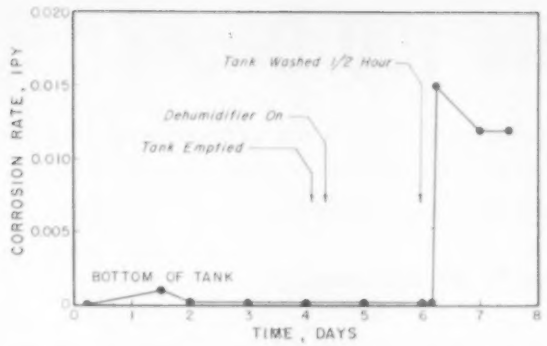

Fig. 7—Tank 4P, diesel fuel with inhibitor. Tank washed and dehumidified.

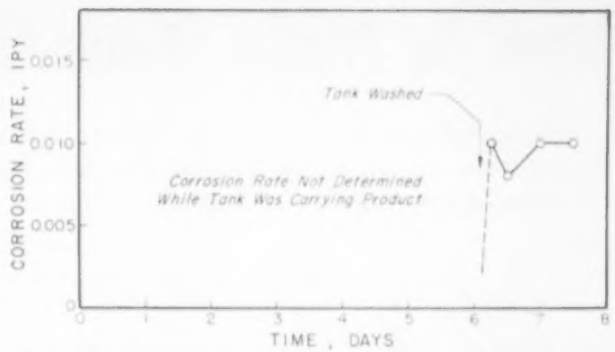

Fig. 8—Tank 5P, Stoddard solvent without inhibitor. Tank washed but not dehumidified.

applied current, corroded at high rates. The generally accepted value for long-term corrosion rates of steel in quiet sea water is 0.005-0.007 in. per year., only about 25 per cent of the corrosion rate found in these tests.

The possible explanation for this discrepancy are (1) the pretreatment, which actually caused some rust to form on the probes, had an accelerating effect, (2) the sea water ballast was highly aerated, or (3) the high rates observed are the initial rates before a protective film of rust or marine organisms forms on the surface.

In any case, the data from these tests strongly support the use of cathodic protection in ballasted tanks.

Rates in empty tanks . . . These data are tabulated in Table 4. The results varied considerably, probably because of various types of surfaces formed on the steel probes before and during the exposure in the empty tanks. Where the probe surface was rusted from its previous exposure, the expected rates were observed.

Where the probe surface was clean, practically zero corrosion rate was observed. Dehumidification had no effect on the corrosion of clean steel probes in empty tanks.

Another point in connection with the tests in empty tanks is that, when the tanks were emptied in Jacksonville, the air entering the tanks was relatively salt free in contrast to the air at marine ports. For this reason, the corrosion rate on bare steel would be expected to be low.

Rates in Washed Tanks

Data for washed tanks are listed in Table 5. A conventional Butterworth machine was used with sea water at 180° F. for ½ hour in each tank. Figs. 3, 6, 7, and 8 show the sharp increase in corrosion rate as the tanks were washed. Dehumidification after washing seemed to have some beneficial effect at first, but there was no apparent improvement with time.

The corrosion rate with or without dehumidification remained at high values from the time the tanks were washed until the end of the tests when the ship reached the refinery. The tanks cooled considerably during this time but the temperature change did not affect the corrosion rate appreciably. Even at the end of the test, all the washed tanks were filled with a mist of water droplets.

Conclusions

1. The oil-soluble inhibitor had a pronounced effect while the tank was carrying gasoline, reducing the corrosion rate to 15-20 per cent of the uninhibited corrosion rate. The bottoms of the gasoline tanks consistently corroded faster than the tops in these experiments.

2. Uninhibited kerosine was almost as corrosive as uninhibited gasoline. Diesel fuel, however, was noncorrosive even without inhibitor.

3. During ballast, inhibitor carried previously in the ballast tank had no effect in reducing corrosion.

4. Magnesium anodes designed to provide a current density of 30 ma. per sq. ft. were effective in reducing corrosion, during sea water ballast, to a negligible value.

5. Washing tanks with hot sea water for ½ hour increased the corrosion rate in the washed tanks 10 or 15 times. Whether or not the tank had previously carried inhibited cargo made no difference in the corrosion rate.

Dehumidification appeared to have some effect but did not reduce the corrosion rate to tolerable levels during the test period.

Acknowledgment

This work was carried out with the fine cooperation of Capt. O. Wass of the S.S. Pure Oil. A. L. Widerquist assisted in the collection of the data.

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2. J. D. Sudbury, D. A. Shock, and F. W. Mann, Corrosion, 10, 253 (1954).
3. Charles P. Dillon, Corrosion, 11, 393 (1955).
4. F. M. Watkins, A.P.I. Tanker Corrosion Research Project Report No. 1, June 17, 1955.

TABLE 4—CORROSION RATES IN SOME EMPTY TANKS

No.	Product previously carried in tank—	Corrosion rate, in./yr.—With dehumidification	Corrosion rate, in./yr.—Without dehumidification
1.	Gasoline, no inhibitor	Not run	0.008
2.	Gasoline + inhibitor	0.002-0.008	0
3.	Diesel fuel + inhibitor	0	0-0.001
4.	Diesel fuel, no inhibitor	0.0005-0.0015	Not run

TABLE 5—CORROSION RATES IN TANKS AFTER WASHING ½ HOUR WITH HOT (180° F.) SEA WATER

No.	Product previously carried in tank—	Corrosion rate, in./yr.—With dehumidification	Corrosion rate, in./yr.—Without dehumidification
1.	Diesel fuel, no inhibitor	0.015	Not run
2.	Diesel fuel + inhibitor	0.012	0.015-0.022
3.	Stoddard, no inhibitor	Not run	0.010

BOOK

OIL AND GAS WELLS IN WESTERN CANADA, Second Edition. Published by Nickle Map Service, Ltd., Blow Building, Calgary, Canada. 122 map sheets, $35 per copy, $100 per year.

This October 1955 issue introduces many new features to this map service. The most important change is an enlargement in scale of all maps from 12 miles equals 1 in. to 6 miles equals 1 in. The over-all book is briefcase size for handy reference.

How to Make Your Own 100 Octane

Those top octane numbers come with a big price tag. When the refiner pays this price he wants to be sure he's getting what he's paying for. Here's a report on tests showing how pure hydrocarbon types can best be blended to attain this end.

by F. D. Buerstetta and T. W. Warren

REFINERS are nearing the time when a finished motor fuel will represent a blend of essentially pure hydrocarbon types. Since each additional octane number near the 100 level may increase cost by as much as 15 to 20 cents per barrel, there is a great incentive for insuring that laboratory quality obtained at great expense provides the desired antiknock performance in passenger cars.

Ethyl Corp. recently conducted a study to establish the behavior characteristics of blends composed of pure hydrocarbons in the C_7-C_8 range. The principal objectives of this investigation were to establish the relative contributions of the four hydrocarbon types to engine antiknock behavior and to relate such behavior to the following variables, which can be defined by control laboratory tests:

1. Research or motor octane number or both.
2. Fuel antiknock quality level.
3. TEL concentration.

Program design . . . An unusual blending approach had to be used to study the effects of hydrocarbon type, hydrocarbon composition, and TEL concentration on hydrocarbon blends at a constant research octane level. Mixtures of isooctane and n-heptane were used as the paraffin constituent. The ratio of these paraffins was varied in order to maintain a constant research octane number while investigating the effects of TEL concentration and variations in hydrocarbon-type composition.

Toluene, diisobutylene, and methyl cyclohexane were used to represent aromatics, olefins, and naphthenes, respectively. Each of these hydrocarbons was blended with the primary-reference-fuel mixtures of isooctane and n-heptane. Ternary blends were made covering all possible combinations of the following variables: concentrations of 0, 20, 40, and 60 per cent by volume for each of the three hydrocarbon inserts; TEL concentrations of 0.0, 0.5, 1.5, and 3.0 ml. per gallon; and nominal research octane levels of 92, 96, and 100.

Complete laboratory octane data were obtained for each blend and for each hydrocarbon constituent. In addition, each blend was evaluated in passenger-car operation.

Authors are with Ethyl Corp. Presented at C.N.G.A. meeting, Los Angeles, October 12-13, 1955.

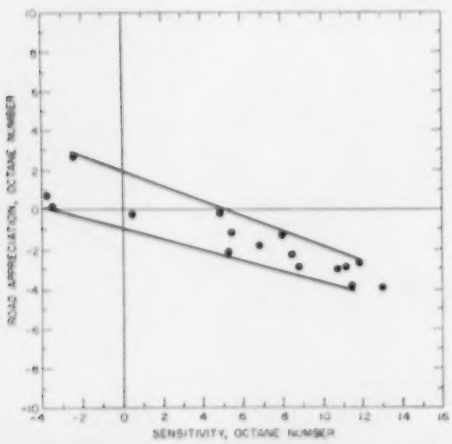
Analysis of Data

Perhaps the most striking observation to be made from an over-all review of the test results is the large variation in road antiknock behavior among fuels of the same research octane number but different hydrocarbon composition; and among fuels of equal research octane number and identical hydrocarbon types, but different TEL concentrations.

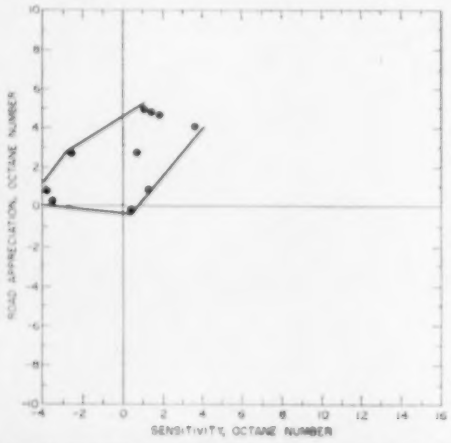
Table I compares the hydrocarbon type blends on the basis of the average change in road appreciation resulting from the addition of aromatic, olefinic, or naphthenic components to the paraffin-base blends. Road appreciation is the road antiknock rating of a fuel, minus its research octane number. This concept is particularly useful for comparing the road antiknock behaviors of two gasolines having different research octane numbers.

These values were compiled from data obtained on 99 test blends consisting of 12 samples containing paraffins alone, 35 containing aromatics, 34 containing olefins, and 18 containing naphthenes.

It is apparent from this table that conclusions with respect to preferred blending bases should not be made without regard to octane level. Appreciation by the 92-research-octane-number (R.O.N.) fuels may have been affected by a retarded spark, while appreciation by the 100-R.O.N. fuels may have been influenced by an advanced spark. Although studies of such effects in the test car have not produced pronounced relationships between spark advance and fuel appreciation, they do indicate the desirability of making behavior comparisons at the vehicle's octane requirement level of 96 R.O.N.



SENSITIVITY VS. APPRECIATION for 96 R. O. N. olefin-paraffin blends at high engine speed ratings. Fig. 1.



SENSITIVITY VS. APPRECIATION for 96 R. O. N. naphthene-paraffin blends at high engine speed ratings. Fig. 2.

Sensitivity and Vehicle Performance

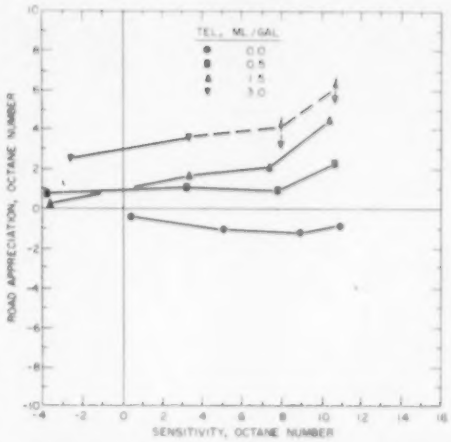
The research and motor methods have been widely used in attempts to define road antiknock quality because they measure antiknock quality at engine operating conditions that are sig-

nificantly different in severity. Sensitivity, which is defined as research minus motor ratings, is the factor generally correlated with vehicle appreciation. With wide-boiling, complex mixtures of hydrocarbon types, two such engine ratings possibly represent the best practical means of relating antiknock quality to performance of the fuel in vehicles.

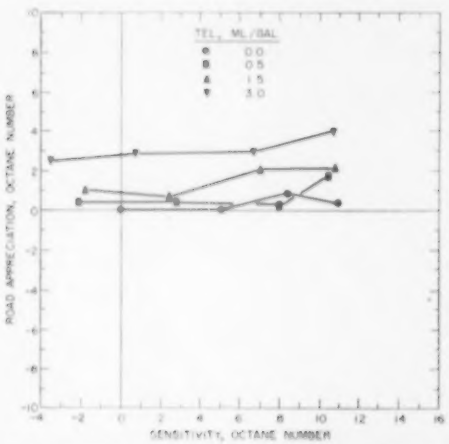
However, the work with pure hydrocarbons illustrates the inadequacy of such a quality measure. When appreciation (road rating minus research rating) is plotted against sensitivity without regard to hydrocarbon type, composition, or TEL concentration, there is no indication of road appreciation in the test car used.

However, correlations are obtained when the blends are separated as to hydrocarbon types. Figs. 1, 2, and 3 show these results. Fig 1 is the correlation obtained with olefin-paraffin blends. Although TEL and olefin concentration are variations in the olefin data, the pattern defined by boundary lines suggests that sensitivity is a fairly reasonable basis for defining road behavior in this case.

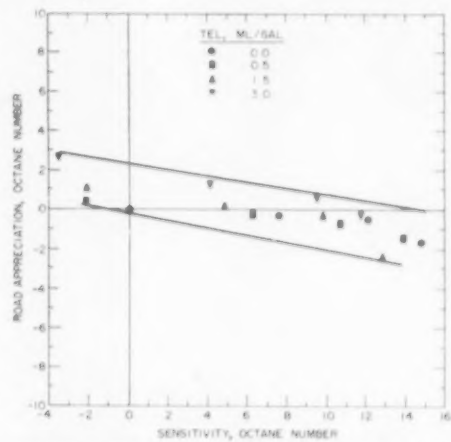
In the same manner, Figs. 2 and 3 isolate the areas common to naphthenes and aromatics. Although defining hydrocarbon type in these instances is a step in the right direction, sensitivity still falls short of giving the desired correlation.



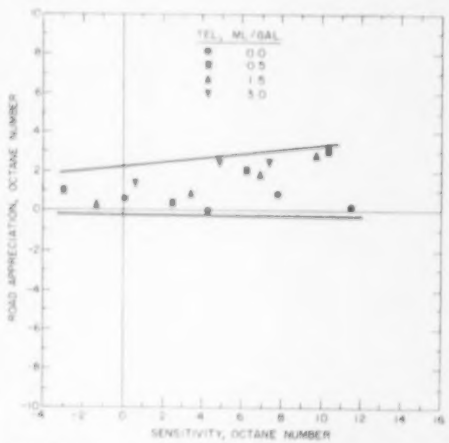
SENSITIVITY VS. APPRECIATION for 96 R. O. N. aromatic-paraffin blends at high engine speed ratings. Fig. 3.



SENSITIVITY VS. APPRECIATION for 100 R. O. N. aromatic-paraffin blends at high engine speed ratings. Fig. 4.



SENSITIVITY VS. APPRECIATION for 100 R. O. N. olefin-paraffin blends at high engine speed ratings. Fig. 5.



SENSITIVITY VS. APPRECIATION for 92 R. O. N. aromatic-paraffin blends at high engine speed ratings. Fig. 6.

Effect of TEL . . . In order to obtain more precise correlation from the aromatic paraffin in Fig. 3, points of the same nominal TEL concentration have been connected. It may be seen that appreciation at any given sensitivity level increases with TEL concentration.

Moreover, when both TEL level and hydrocarbon type are defined, Fig. 5 suggests that a definition of sensitivity is required to predict road appreciation only at appreciable TEL concentrations of 1.5 ml. per gallon and above.

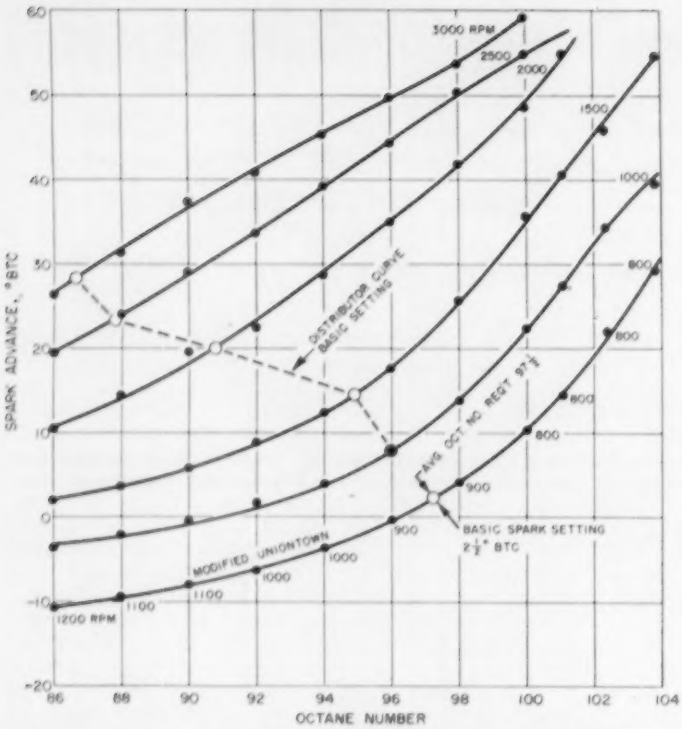
The range of sensitivity covered by the naphthene-paraffin blends is too small to permit attributing behavior differences to this factor. Nevertheless, as in the case of the aromatic blends, appreciation generally increases with TEL concentration.

Thus, from the analysis represented by Figs. 1-3, we have established that sensitivity alone fails as a criterion of road behavior relative to laboratory behavior. For olefins, the additional criterion of defining hydrocarbon type permits a reasonable estimate of appreciation. In the case of aromatics, defining TEL concentration in addition to hydrocarbon type establishes behavior within narrow limits, with sensitivity a factor only at appreciable TEL concentrations. For naphthenes, where sensitivity variation is small, TEL con-

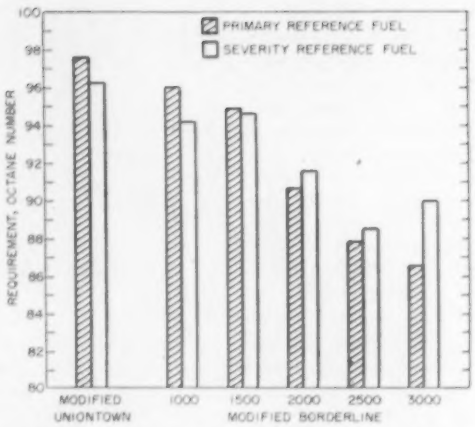
TABLE I—AVERAGE CHANGE IN ROAD ANTIKNOCK APPRECIATION WITH ADDITION OF AROMATICS, OLEFINS, OR NAPHTHENES TO PARAFFINS

	Nominal R.O.N.	Modified Uniontown	Modified borderline—Low speed	Modified borderline—High speed
Aromatics	92	0.6	1.1	0.6
	96	0.9	1.7	0.6
	100	0.8	1.5	*—0.7
Olefins	92	0.3	1.1	—2.0
	96	1.6	1.1	—3.3
	100	0.5	0.0	*—5.7
Naphthenes	92	0.6	2.0	3.8
	96	2.4	4.2	2.7
	100	3.4	*3.7	*1.7

*Minimum appreciation based on estimates.



MODIFIED UNIONTOWN AND BORDERLINE primary reference fuel curves (average of all results). Speed of trace knock is noted at each point on modified Uniontown curve. Fig. 7.



VEHICLE OCTANE REQUIREMENTS, obtained using primary and severity reference fuels. Fig. 8.

centration is an indicator of appreciation.

Other octane levels . . . This analysis has been restricted to the knocking characteristics of 96 - research - octane-number fuels at high engine speeds. Analyses based on both high and low-engine-speed behavior of fuels at the other two octane levels (92 and 100 R.O.N.) lead to the same general conclusion that supplementing sensitivity data with a knowledge of hydrocarbon type and/or TEL concentration establishes behavior with a much greater certainty than does sensitivity alone.

Low-engine-speed behavior of aromatic-paraffin blends at the 100-research-octane level is shown in Fig. 4. TEL concentration is perhaps the major factor in establishing road behavior relative to research octane number.

Fig. 5 portrays the low-engine-speed behavior of olefin-paraffin blends at the 100-research-octane level. There is a marked similarity between this pattern and that depicted in Fig. 2.

The behavior of aromatic - paraffin blends at the 92-research-octane level and high engine speed is shown on Fig. 6. The effect of TEL concentration and the uncertain sensitivity effect are again noted with this hydrocarbon type.

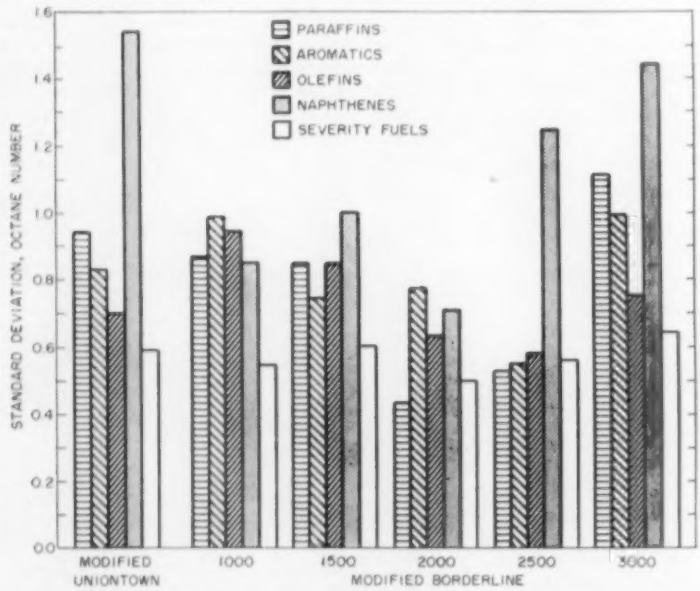
Every combination of research octane level and engine speed has been similarly analyzed. Although there are, of course, some inconsistencies, the over-all behavior conclusions set forth are borne out very well.

Laboratory evaluation . . . Laboratory antiknock ratings were obtained on both the hydrocarbon components and the test blends by the A.S.T.M. motor and research methods. Duplicate research determinations were made in all instances to increase reliability of the data.

Additional laboratory inspection information, such as the effect of TEL on motor and research ratings, were obtained on the base components and are summarized in Table 3. These average octane-number values furnish the basis upon which the blending octane-number values of individual hydrocarbons were later computed.

Road Evaluation

The vehicle selected for knockrating the blends was a 1955 production model having a V-8 engine of about 9-to-1 compression ratio and requiring fuels of 96-research-octane number for knock-free operation.



OCTANE-NUMBER STANDARD DEVIATION of fuel road ratings. Fig. 9.

Although the blends were coded prior to evaluation, they were scheduled for rating in random sequence. This test procedure was used to help insure unbiased consideration of the test blend variables and to minimize the effects of possible variations in barometric pressure or vehicle requirement. Ambient temperature and relative humidity were controlled by conducting the entire operation in one of Ethyl's "all weather" chassis dynamometer rooms.

Two road ratings . . . Road antiknock ratings for each fuel were obtained by both the Modified Uniontown technique (C.R.C. Designation F-28) and the Modified Borderline technique (C.R.C. Designation F-27). The Modified Uniontown technique consists of full-throttle acceleration of the test vehicle, with variations in the basic distributor spark advance until trace knock is obtained during the acceleration for either the test or the reference fuel.

A rating equal to the octane number of the matching reference fuel is given to the test fuel without regard for the speed of maximum knock. The Modified Borderline technique also provides octane rating in terms of mixtures of isooctane and n-heptane. However, this method gives ratings at specific engine speeds and permits antiknock measurements over the entire speed range.

During a full-throttle acceleration, the vehicle spark setting is continuously adjusted to maintain a trace knock on both test and reference fuels. From these data the octane numbers of the test fuels are determined at the desired engine speeds.

To minimize the possibility of unreliable data, each determination was made at least twice, thereby requiring over 1,500 separate road ratings to be obtained on the 99 test blends. In addition to the test fuels, severity reference fuels (sensitive fuel containing mixtures of isooctane, n-heptane, and diisobutylene) were included in each day's schedule.

They covered a range in octane numbers sufficient to bracket the car's octane-number requirements at engine speeds up to 3,000 r.p.m. Inclusion of these fuels provided a continuous check on the car's fuel knock-rating characteristics.

Test Data

The road and laboratory antiknock data for the 99 test blends are represented in Table 8. The data are segregated with respect to hydrocarbon type and concentration so that blends of similar composition appear together.

The composition data of the paraffin base fuel are reported for each blend in terms of volume-percentage concentrations of isooctane and normal heptane. Blending of some fuel compositions was impossible because the research-octane-number quality of the hydrocarbon insert was either inadequate or excessive.

Octane numbers in excess of 100 are based on the relationship:

$$\text{O.N.} = 128 - \frac{2{,}800}{\text{Performance number}}$$

Modified Borderline data were obtained for engine operating speeds of from 1,000 to 3,000 r.p.m. In certain cases, particularly at the higher engine speeds, samples could not be made to knock within the range of spark advance established by primary reference fuels. A dash has been entered in the data tables to indicate this situation.

Road antiknock ratings and the attendant appreciation values are reported to 0.1 octane number.

The significance of differences of a few tenths magnitude is, however, open to question, particularly when considering that the historical standard deviation by this testing technique is somewhere near ±1-octane number. Therefore, in studying the road-test results trends and general differences are more significant than minute differences established in isolated instances.

TABLE 2—AVERAGE ROAD-APPRECIATION DATA OBTAINED AT 96 R.O.N. LEVEL

Blend composition, vol. per cent				Appreciation, Oct. No.	
Paraffin	Olefin	Aromatic	TEL ml./gal.	Low speed	High speed
100			1.5	—0.3	0.2
100			3.0	0.4	3.0
80	20		1.5	0.4	—2.1
80	20		3.0	0.8	—0.1
60	40		1.5	1.6	—2.1
60	40		3.0	0.8	—1.1
80		20	1.5	—0.2	1.7
80		20	3.0	0.5	3.6
60		40	1.5	2.2	2.1
60		40	3.0	3.8	3.2

Reference curves . . . The average primary-reference-fuel framework curves, showing the relationship of octane number to spark advance for both road methods are shown in Fig. 7.

The distributor-advance curve has been superimposed on the Modified Borderline framework pattern, thereby providing the octane-number requirement of the car at the various engine speeds. These average primary-reference-fuel requirements, together with similar established data using severity reference fuels, are summarized in a bar-graph plot in Fig. 8.

Blending Values

Laboratory antiknock data permit calculation of octane-blending values for the aromatic, olefin, and naphthene components. By assigning isooctane and n-heptane their actual octane rating, multiplying such ratings by the volumetric fraction of the two paraffins, and subtracting these numbers from the actual rating of the blend, a difference is obtained. Dividing this difference by the volumetric fraction of aromatic, olefin, or naphthene in the blend gives a blending octane number.

Thus, any blending effect is attributed solely to the one component. Blending values calculated in this manner are presented in Tables 4, 5, and 6. Table 7 contains calculated values of research blending octane number of n-heptane as derived from data on binary blends of n-heptane and isooctane.

Precision of blend data . . . Background data acquired on Ethyl's laboratory antiknock ratings indicate that the average of two research ratings will be

TABLE 3—CHEMICAL AND PHYSICAL PROPERTIES OF THE HYDROCARBON COMPONENTS

Hydrocarbon—	Isooctane	n-Heptane	Toluene	Diisobutylene	Methyl cyclohexane
Normal boiling point, °F.	211	209	231	208-218	214
A.S.T.M. octane number:					
Motor:					
0.0 ml./gal. TEL	100.0	0.0	105.3	84.3	73.0
0.5 ml./gal. TEL	103.8	10.1	107.1	86.5	77.5
1.5 ml./gal. TEL	106.9	29.1	108.5	87.0	82.6
3.0 ml./gal. TEL	108.9	43.0	108.5	87.5	85.2
Research:					
0.0 ml./gal. TEL	100.0	0.0	108.3	102.7	75.2
0.5 ml./gal. TEL	103.8	6.4	108.3	103.3	79.9
1.5 ml./gal. TEL	106.9	23.2	108.3	103.6	85.9
3.0 ml./gal. TEL	108.9	42.4	108.3	104.1	88.8
Gravity, °A.P.I.	73.0	75.6	31.2	64.6	51.7
R.v.p., psi.	1.8	1.7	1.3	1.9	1.8
Sulfur, weight per cent	0.003	0.003	0.022	0.017	<0.002

Octane numbers over 100 based on relationship: $\text{Octane No.} = 128 - \frac{2{,}800}{\text{Performance number}}$

within 0.2 octane numbers of the unknown true value 95 per cent of the time. For this program, it may be assumed that the standard error of estimate in the calculated blending value is inversely proportional to the concentration of the insert hydrocarbon.

Accuracy of the data . . . The bar graph shown in Fig. 9 portrays the calculated octane-number standard deviation values for rating of severity reference fuels and test blends of the four hydrocarbon types. Comparison reveals that the blends containing the naphthene were generally more difficult to rate with a high degree of precision than were the other blends. In general, however, the low deviation levels obtained for both the test blends and the severity reference fuels reflect a significantly high rating accuracy.

Making Future Gasolines

Future refinery situations may be characterized by a motor-gasoline pool consisting of three hydrocarbon types—olefins, aromatics, and paraffins. Aromatics will undoubtedly be a major component in most situations as a result of catalytic reforming.

A typical refining situation may be one in which the blending of gasoline is flexible to the extent of using either diisobutylene (olefins) or toluene (aromatics) in concentrations of up to 40 per cent in a paraffin-base fuel, with TEL concentrations from 1.5 to 3.0 ml. per gal. It is then possible to postulate certain blending principles which should provide maximum vehicle performance for the selected octane level.

Table 2 compares average road-appreciation data obtained at the 96-R.O.N. level. The values represent blends that cover the refining situation under consideration.

With only aromatics and paraffins available to blend a critical-grade gasoline, the optimum composition for low-speed knock performance is highly aromatic (40 per cent) with maximum TEL. Aromatic concentration is less critical for high-speed performance, but high TEL is essential. When considering an optimum fuel for both low and high speeds, the highly aromatic blend with maximum TEL would be preferred.

If only olefins and paraffins are available, highly olefinic blends with moderate TEL levels would be indicated for a low-speed knock criterion. For high-speed performance, highly paraffinic (100 per cent) blends are definitely superior provided they contain high TEL concentrations. Highly paraffinic blends with 3.0 ml. per gallon TEL would be preferred if fuels were being tailored for the over-all speed range.

TABLE 4—BLENDING RESEARCH OCTANE NUMBERS OF TOLUENE IN ISOOCTANE-N-HEPTANE BLENDS

Research octane of final blend		Blending values		
Toluene vol. %	TEL ml./gal.	92	96	100
20	0.0	123.2	121.6	118.8
40		125.2	123.1	120.6
60		126.8	124.2	123.6
20	0.5	131.2	130.0	126.6
40		129.0	128.8	125.5
60		130.2	127.7	123.9
20	1.5	140.2	135.0	129.5
40		133.2	130.1	125.7
60		131.9	129.0	125.2
20	3.0	130.6	124.7	119.6
40		128.9	126.4	121.5
60			126.0	121.4

TABLE 5—BLENDING RESEARCH OCTANE NUMBERS OF DIISOBUTYLENE (DIB) IN ISOOCTANE-N-HEPTANE BLENDS

Research octane of final blend		Blending values		
DIB vol. %	TEL ml./gal.	92	96	100
20	0.0	152.6	147.4	140.4
40		144.6	140.0	132.7
60		140.1	135.1	126.6
20	0.5	160.4	156.2	144.9
40		151.8	147.5	141.6
60		146.8	142.0	134.6
20	1.5	162.2	155.6	144.6
40		149.7	144.6	138.2
60			140.0	134.0
20	3.0	144.1	139.2	132.1
40		137.3	134.6	129.7
60			131.8	128.2

TABLE 6—BLENDING RESEARCH OCTANE NUMBERS OF METHYL CYCLOHEXANE (MCH) IN ISOOCTANE-N-HEPTANE BLENDS

Research octane of final blend		Blending values		
MCH vol. %	TEL ml./gal.	92	96	100
20	0.0	75.2		
40				
60				
20	0.5	84.6	91.8	
40		79.4		
60				
20	1.5	100.2	93.8	85.2
40		87.2	88.2	
60		85.3		
20	3.0	94.3	89.6	84.6
40		92.6	87.8	85.2
60		88.0		

TABLE 7—BLENDING RESEARCH OCTANE NUMBERS OF N-HEPTANE BLENDED WITH ISOOCTANE

Research octane of final blend	Blending values		
TEL (ml./gal.)	92	96	100
0.0	—4.4	3.8	0.0
0.5	14.7	16.6	14.1
1.5	37.8	37.6	34.4
3.0	47.6	46.0	36.9

With all three hydrocarbon types available, a refiner would divert olefins to the less critical grade of gasoline and would use maximum TEL in highly aromatic (40 per cent) blends with paraffins for a critical fuel with superior low speed or over-all speed performance. Aromatic concentration would be decreased somewhat if high-speed performance were critical.

Acknowledgment

The authors acknowledge with thanks the efforts of their coworkers whose work has contributed to the program described in this paper. The contributions of H. J. Sewell, Ethyl research engineer, and Norman E. Van Huff, a recent student employe of Ethyl Corp. and now an engineering senior at Wayne University, have been particularly valuable.

TABLE 8—DETAILED DATA FROM OCTANE TESTS

(Note: All octane numbers are averaged values)

Blend No.—	Composition, vol. %			TEL	Laboratory O.N.			Modified Uniontown		Modified Borderline							
										1,000		1,500		2,000		2,500		3,000	
	Hydroc.	Iso.	Hep.	ml./gal.	F-1	F-2	Sens.	O.N.	Appr.	O.N.	Appr.	O.N.	Appr.	O.N.	Appr.	O.N.	Appr.	O.N.	Appr.
Octane No. 92:																			
1	0	92.0	8.0	0.0	91.6	91.6	0.0	91.9	0.3	94.4	2.8	92.5	0.9	92.6	1.0	92.3	0.7	92.8	1.2
2	0	86.7	13.3	0.49	92.0	95.1	—3.1	90.8	—1.2	93.4	1.4	93.4	1.4	93.2	1.2	93.0	1.0	94.4	2.4
3	0	79.2	20.8	1.46	92.4	94.0	—1.6	91.9	—0.5	91.9	—0.5	92.6	0.2	93.1	0.7	92.6	0.2	92.3	—0.1
4	0	73.7	26.3	2.97	92.8	92.3	0.5	93.0	0.2	93.4	0.6	92.8	0.0	94.7	1.9	94.4	1.6	95.1	2.3
Octane No. 96:																			
6	0	96.0	4.0	0.0	96.2	96.0	0.2	95.2	—1.0	96.0	—0.2	96.0	—0.2	96.4	0.2	95.9	—0.3	95.4	—0.8
7	0	91.9	9.0	0.49	96.0	100.1	—4.1	95.4	—0.6	96.4	0.4	96.3	0.3	95.6	—0.4	96.9	0.9	.....	.....
8	0	84.9	15.1	1.48	96.4	100.0	—3.6	96.6	0.2	96.1	—0.3	96.8	0.4	96.5	0.1	96.6	0.2	.....	.....
9	0	80.6	19.4	2.99	96.7	99.2	—2.5	95.0	—1.7	97.1	0.4	98.6	1.9	98.5	1.8	99.6	2.9	.....	.....
Octane No. 100:																			
11	0	100.0	0.0	0.0	100.0	100.0	0.0	99.8	—0.2	100.0	0.0	100.0	0.0	99.6	—0.4	99.5	—0.5	.....	.....
12	0	95.6	4.4	0.48	99.8	102.0	—2.2	99.8	0.0	99.8	0.0	100.1	0.3	100.2	0.4	.....	.....	.....	.....
13	0	91.2	8.8	1.48	100.5	102.6	—2.1	100.1	—0.4	100.6	0.1	101.5	1.0	101.3	0.8	.....	.....	.....	.....
14	0	88.2	11.8	3.00	100.5	104.0	—3.5	100.6	0.1	101.6	1.1	103.0	2.5	.....	.....	.....	.....	.....	.....

TABLE 8—DETAILED DATA FROM OCTANE TESTS (Continued)

TOLUENE BLENDS

Blend No.— Octane No. 92:	Composition, vol. %— Hydroc.	Iso.	Hep.	TEL ml./gal.	Laboratory O.N. F-1	F-2	Sens.	Modified Uniontown O.N.	Appr.	Modified Borderline 1,000 O.N.	Appr.	1,500 O.N.	Appr.	2,000 O.N.	Appr.	2,500 O.N.	Appr.	3,000 O.N.	Appr.
16																			
17	20	67.2	12.8	0.0	91.8	87.6	4.2	92.0	0.2	93.9	2.1	93.2	1.4	92.6	0.8	91.8	0.0	91.6	—0.2
18	20	62.1	17.9	0.49	91.8	89.3	2.5	91.0	—0.8	92.5	0.7	92.1	0.3	92.5	0.7	92.1	0.3	92.8	1.0
19	20	54.64	25.36	1.47	92.2	88.7	3.5	91.8	—0.4	92.4	0.2	92.2	0.0	93.3	1.1	93.1	0.9	94.0	1.8
Octane No. 96:	20	48.3	31.7	2.95	92.2	87.4	4.8	92.9	0.7	94.5	2.3	94.1	1.9	95.0	2.8	94.6	2.4	94.9	2.7
21																			
22	20	71.44	8.56	0.0	95.8	90.8	5.0	96.0	0.2	97.0	1.2	96.0	0.2	95.8	0.0	94.8	—1.0	94.8	—1.0
23	20	66.6	13.4	0.48	96.0	92.9	3.1	95.6	—0.4	95.6	—0.4	95.2	—0.8	96.2	0.2	97.0	1.0	97.9	1.9
24	20	60.1	19.9	1.48	95.8	92.5	3.3	95.2	—0.6	95.6	—0.2	96.4	0.6	97.0	1.2	97.5	1.7		
Octane No. 100:	20	55.7	24.3	3.01	95.9	92.6	3.3	96.2	0.3	96.4	0.5	97.8	1.9	98.4	2.5	99.5	3.6		
26																			
27	20	75.6	4.4	0.0	99.4	94.4	5.0	99.4	0.0	99.4	0.0	99.3	—0.1	97.8	—1.6	96.6	—2.8	96.6	—2.8
28	20	71.1	8.9	0.49	99.7	97.1	2.6	99.4	—0.3	100.0	0.3	100.0	0.3	99.8	0.1	100.2	0.5		
29	20	65.6	14.4	1.47	99.3	97.0	2.3	99.1	—0.2	99.8	0.5	100.0	0.7	100.1	0.8	100.2	0.9		
Octane No. 92:	20	63.04	16.96	2.99	99.8	99.0	0.8	101.1	1.3	102.6	2.8	102.7	2.9						
31																			
32	40	41.88	18.12	0.0	92.0	84.2	7.8	90.7	—1.3	94.4	2.4	93.8	1.8	92.9	0.9	92.8	0.8	93.2	1.2
33	40	36.66	23.34	0.49	91.2	85.0	6.2	91.8	0.6	93.2	2.0	92.7	1.5	93.1	1.9	93.2	2.0	93.8	2.6
34	40	29.4	30.6	1.46	91.8	84.9	6.9	93.5	1.7	93.5	1.7	92.8	1.0	93.7	1.9	93.5	1.7	94.6	2.8
Octane No. 96:	40	23.1	36.9	2.96	92.4	85.0	7.4	94.0	1.6	95.6	3.2	94.5	2.1	94.8	2.4	94.6	2.2	94.5	2.1
36																			
37	40	46.62	13.38	0.0	95.8	87.4	8.4	96.0	0.2	96.3	0.5	96.2	0.4	96.5	0.7	94.6	—1.2	93.9	—1.9
38	40	41.7	18.3	0.50	96.0	88.3	7.7	95.2	—0.8	96.8	0.8	96.4	0.4	96.4	0.4	97.0	1.0	96.0	0.0
39	40	35.88	24.12	1.49	96.0	88.6	7.4	95.5	—0.5	98.2	2.2	98.6	2.6	97.6	1.6	98.1	2.1	98.9	2.9
Octane No. 100:	40	30.0	30.0	2.98	96.0	88.1	7.9	97.4	1.4	99.8	3.8	99.3	3.3	98.6	2.6	99.2	3.2		
41																			
42	40	51.36	8.64	0.0	99.6	91.5	8.1	100.0	0.4	100.3	0.7	100.3	0.7	99.2	—0.4	97.4	—2.2	96.2	—3.4
43	40	47.04	12.96	0.48	99.8	92.2	7.6	99.8	0.0	100.2	0.4	100.0	0.2	100.4	0.6				
44	40	42.96	17.04	1.48	100.1	92.8	7.3	100.7	0.6	102.3	2.2	102.3	2.2	100.5	0.4				
Octane No. 92:	40	38.64	21.36	2.98	99.8	93.1	6.7	101.3	1.5	103.2	3.4	102.8	3.0						
46																			
47	60	16.4	23.6	0.0	92.5	81.2	11.3	92.6	0.1	94.4	1.9	92.3	—0.2	92.6	0.1	92.6	0.1	91.6	—0.9
48	60	11.32	28.68	0.48	91.7	81.4	10.3	91.8	0.1	95.1	3.4	93.9	2.2	94.4	2.7	94.9	3.2	94.8	3.1
Octane No. 96:	60	3.92	36.08	1.47	91.7	81.9	9.8	92.2	0.5	95.2	3.5	95.0	3.3	94.7	3.0	94.6	2.9	94.8	3.1
51																			
52	60	21.84	18.16	0.0	96.4	85.5	10.9	97.4	1.0	98.2	1.8	96.8	0.4	96.4	0.0	95.6	—0.8	94.8	—1.6
53	60	17.04	22.96	0.49	95.8	85.2	10.6	95.0	—0.8	98.0	2.2	97.6	1.8	97.0	1.2	97.9	2.1		
54	60	10.76	29.24	1.48	95.6	85.4	10.2	95.3	—0.3	100.0	4.4	99.2	3.6	98.5	2.9	100.0	4.4		
Octane No. 100:	60	5.48	34.52	2.99	96.2	85.3	10.9	97.4	1.2	101.0	4.8	100.2	4.0	100.0	3.8				
56																			
57	60	28.16	11.84	0.0	100.4	89.7	10.7	100.8	0.4	101.7	1.3	100.7	0.3	99.5	—0.9	99.5	—0.9		
58	60	23.44	16.56	0.49	99.8	89.6	10.2	101.2	1.4	102.7	2.9	101.4	1.6	101.2	1.4				
59	60	18.72	21.28	1.47	100.0	89.4	10.6	100.9	0.9	103.5	3.5	103.0	2.0						
	60	14.72	25.82	3.02	99.8	89.2	10.6	102.1	2.3	103.8	4.0	103.2	3.4						

DIISOBUTYLENE BLENDS

Octane No. 92:																			
61	20	61.28	18.72	0.0	91.8	86.0	5.8	91.8	0.0	94.1	2.3	91.9	0.1	91.7	—0.1	90.3	—1.5	89.4	—2.4
62	20	56.0	24.0	0.51	91.8	87.6	4.2	90.6	—1.2	93.3	1.5	92.4	0.6	92.0	0.2	91.0	—0.8	90.7	—1.1
63	20	48.88	31.12	1.49	91.8	87.1	4.7	90.5	—1.3	93.0	1.2	93.5	1.7	92.5	0.7	90.4	—1.4	90.4	—1.4
64	20	44.08	35.92	2.99	92.0	87.8	4.2	90.8	—1.2	92.5	0.5	91.2	1.2	93.6	1.6	92.6	0.6	91.1	—0.9
Octane No. 96:																			
66	20	66.08	13.92	0.0	95.6	89.2	6.4	96.8	1.2	97.1	1.5	95.7	0.1	95.0	—0.6	93.8	—1.8	91.8	—3.8
67	20	61.04	18.96	0.49	95.8	90.5	5.3	96.4	0.6	97.2	1.4	96.2	0.4	95.0	—0.8	94.6	—1.2	94.5	—1.3
68	20	55.6	24.4	1.49	96.2	91.1	5.1	94.4	—1.8	96.6	0.4	96.8	0.6	94.8	—1.4	94.1	—2.1	93.9	—2.3
69	20	51.12	28.88	2.98	95.8	91.0	4.8	96.0	0.2	96.6	0.8	96.6	0.8	96.5	0.7	95.7	—0.1	94.6	—1.2
Octane No. 100:																			
71	20	71.28	8.72	0.0	99.4	91.8	7.6	99.9	0.5	99.9	0.5	99.2	—0.2	97.7	—1.7	95.5	—3.9	93.3	—6.1
72	20	66.4	13.6	0.49	99.7	93.5	6.2	99.8	0.1	99.1	—0.6	99.5	—0.2	98.4	—1.3	97.0	—2.7	93.9	—5.8
73	20	62.72	17.28	1.46	99.9	95.0	4.9	100.7	0.8	100.4	0.5	100.2	0.3	98.8	—1.1	97.8	—2.1	97.2	—2.7
74	20	59.12	20.88	2.98	99.6	95.6	4.0	100.3	0.7	100.9	1.3	100.8	1.2	101.1	0.5	100.1	0.5	98.6	—1.0
Octane No. 92:																			
76	40	33.78	26.22	0.0	91.6	83.1	8.5	93.4	1.8	94.1	2.5	92.8	1.2	91.6	0.0	90.0	—1.6	88.6	—3.0
77	40	27.6	32.4	0.49	91.4	84.0	7.4	91.6	0.2	94.3	2.9	93.0	1.6	91.7	0.3	90.9	—0.5	89.8	—1.6
78	40	21.36	38.64	1.48	91.6	84.6	7.0	91.4	—0.2	94.0	2.4	92.2	0.6	91.8	0.2	90.4	—1.2	89.3	—2.3
79	40	15.72	44.28	2.97	90.8	84.3	6.5	89.6	—1.2	93.2	2.4	91.5	0.7	92.8	2.0	91.1	0.3	89.8	—1.0
Octane No. 96:																			
81	40	40.02	19.98	0.0	96.0	85.4	10.6	97.0	1.0	97.2	1.2	96.0	0.0	94.9	—1.1	93.0	—3.0	91.2	—4.8
82	40	33.48	26.52	0.50	95.4	86.8	8.6	96.6	1.2	96.0	0.6	95.4	0.0	94.4	—1.0	92.6	—2.8	90.7	—4.7
83	40	28.5	31.5	1.48	95.6	87.2	8.4	96.2	0.6	97.7	2.1	96.5	0.9	95.0	—0.6	93.5	—2.1	92.5	—3.1
84	40	23.82	36.18	2.99	95.1	87.2	7.9	95.9	0.8	95.9	0.8	96.0	0.9	95.6	0.5	94.0	—1.1	92.3	—2.8
Octane No. 100:																			
86	40	46.62	13.38	0.0	99.7	87.7	12.0	100.2	0.5	100.2	0.5	99.2	—0.5	97.2	—2.5	94.7	—5.0	92.2	—7.5
87	40	39.96	20.04	0.49	99.4	88.8	10.6	99.5	0.1	99.4	0.0	98.6	—0.8	97.0	—2.4	95.4	—4.0	92.8	—6.6
88	40	36.12	23.88	1.50	99.6	89.8	9.8	100.4	0.8	99.8	0.2	99.3	—0.3	97.0	—2.6	95.2	—4.4	93.7	—5.9
89	40	33.06	26.94	2.99	99.3	90.0	9.3	101.2	1.9	101.0	1.7	100.0	0.7	99.0	—0.3	96.2	—3.1	93.8	—5.5
Octane No. 92:																			
91	60	7.68	32.32	0.0	91.8	80.4	11.4	93.0	1.2	95.0	3.2	92.2	0.4	90.6	—1.2	89.0	—2.8	87.6	—4.2
92	60	1.2	38.8	0.48	91.8	81.2	10.6	93.8	2.0	94.2	2.4	93.4	1.6	91.1	—0.7	89.2	—2.6	87.6	—4.2
Octane No. 96:																			
96	60	14.8	25.2	0.0	95.8	83.0	12.8	96.4	0.6	97.0	1.2	95.4	—0.4	93.9	—1.9	91.8	—4.0	89.8	—6.0
97	60	7.92	32.08	0.51	95.5	83.6	11.9	97.8	2.3	97.9	2.4	96.4	0.9	94.2	—1.3	92.8	—2.7	90.4	—5.1
98	60	3.2	36.8	1.50	96.0	84.8	11.2	97.1	1.1	97.8	1.8	96.6	0.6	94.3	—1.7	92.2	—3.8	90.1	—5.9
99	60	0.2	39.8	2.98	96.2	85.2	11.0	98.2	2.0	97.1	0.9	98.6	2.4	96.3	0.1	93.1	—3.1	90.6	—5.6
Octane No. 100:																			
101	60	24.0	16.0	0.0	100.0	85.4	14.6	99.1	—0.9	100.0	0.0	98.3	—1.7	96.1	—3.9	93.0	—7.0	90.4	—9.6
102	60	17.16	22.84	0.50	100.0	86.3	13.7	99.8	—0.2	100.1	0.1	98.6	—1.4	96.2	—3.8	93.6	—6.4	91.2	—8.8
103	60	12.64	27.36	1.52	100.3	87.5	12.8	99.9	—0.4	98.8	—1.5	97.9	—2.4	94.9	—5.4	92.6	—7.7	90.0	—10.3
104	60	8.32	31.68	3.00	99.4	87.6	11.8	100.0	0.6	100.6	1.2	99.6	0.2	97.1	—2.3	94.4	—5.0	92.1	—7.3

METHYL CYCLOHEXANE BLENDS

Octane No. 92:																			
106	20	76.56	3.44	0.0	91.6	88.5	3.1	89.6	—2.0	93.6	2.0	94.0	2.4	95.8	4.2	94.9	3.3	92.4	0.8
107	20	71.84	8.16	0.49	92.0	91.9	0.1	91.8	—0.2	94.4	2.4	94.0	2.0	94.8	2.8	95.4	3.4	95.0	3.0
108	20	64.24	15.76	1.49	92.3	89.3	3.0	91.3	—1.0	92.9	0.6	93.1	0.8	95.3	3.0	95.4	3.1	95.4	3.1
109	20	58.08	21.92	3.00	91.4	89.7	1.7	91.1	—0.3	91.4	0.0	93.0	1.6	95.4	4.0	94.7	3.3	97.2	5.8
Octane No. 96:																			
112	20	77.12	2.88	0.50	98.6	97.3	1.3	100.0	1.4	100.3	1.7	100.5	1.9	100.2	1.6	99.4	0.8	99.7	1.1
113	20	71.04	8.96	1.49	96.7	96.0	0.7	97.4	0.7	98.2	1.5	99.4	2.7	98.6	1.9	99.3	2.6		
114	20	66.4	13.6	3.00	96.0	94.9	1.1	96.3	0.3	100.4	4.4	100.4	4.4	100.8	4.8	101.0	5.0		
Octane No. 100:																			
118	20	77.36	2.64	1.49	100.3	100.0	0.3	103.0	2.7	102.8	2.5	102.8	2.5						
119	20	73.76	6.24	2.98	99.9	100.7	—0.8	102.6	2.7										
Octane No. 92:																			
122	40	56.1	3.9	0.50	90.2	88.8	1.4	91.1	0.9	94.3	4.1	94.3	4.1	96.2	6.0	95.8	5.6	94.2	4.0
123	40	47.4	12.6	1.50	88.4	87.4	1.0	87.6	—0.8	93.3	4.9	90.3	1.9	93.3	4.9	94.4	6.0	93.9	5.5
124	40	43.26	16.74	2.97	91.2	89.6	1.6	91.2	0.0	93.3	2.1	94.2	3.0	97.3	6.1	97.3	6.1	98.2	7.0
Octane No. 96:																			
128	40	56.28	3.72	1.48	96.2	94.8	1.4	97.6	1.4	100.9	4.7	100.8	4.6	100.2	4.0	101.0	4.8	100.0	3.8
129	40	51.6	8.4	2.97	94.8	93.3	1.5	97.1	2.3	99.9	5.1	101.5	6.7	100.6	5.8	99.4	4.6		
Octane No. 100:																			
134	40	60.0	0.0	2.96	99.4	97.7	1.7	103.8	4.4										
Octane No. 92:																			
138	60	38.2	1.8	1.48	92.4	89.8	2.6	92.0	—0.4	97.8	5.4	98.7	6.3	98.1	5.7	96.9	4.5	95.3	2.9
139	60	33.0	7.0	3.00	91.7	88.9	2.8	93.0	1.3	97.6	5.9	100.3	8.6	100.5	8.8	98.5	6.8	96.3	4.6
tane No. 96:																			
144	60	40.0	0.0	2.98	95.4	91.8	3.6	99.2	3.8	103.8	8.4	102.0	6.6	100.6	5.2	99.4	4.0	98.4	3.0

That Other 50 Per Cent

Reservoir Engineering Begins Second 25 Years

The author says . . .

1. Technological progress has led to a substantial increase in the amount of oil recoverable by modern producing methods.

2. Many important oil fields by current production practices will yield well over 50 per cent of the oil originally in place.

3. There are still some areas in which legal, economic, or administrative problems discourage the use of the best production practice; and in these there is an opportunity, through improved production practice, to recover much additional oil.

4. Further development in reservoir-engineering technology will lead to further refinement in conventional production practice and more widespread application of good practice which will add to the recoverable reserves of oil.

5. There are some types of fields, for example, those which produce heavy viscous oil and those where the oil is held in extraordinarily tight reservoir rock, where present-day production practices will not recover economically a large fraction of the oil in place.

6. The petroleum industry is actively engaged in research and development of new methods of recovering oil which should make it physically possible to recover a large fraction of the oil originally in place.

7. These new methods are expensive, and although it is unlikely that they can be applied profitably in all oil fields, they will find important commercial application in many areas.

by Thomas V. Moore

RESERVOIR engineering is the art of developing and producing oil fields in such a way as to obtain a high economic recovery. Modern reservoir engineering had its beginning about 1930, when the practice of measuring gas and water production became common, when reliable instruments were developed for measuring pressure and temperatures in wells, when equipment became available for obtaining fluid samples under reservoir conditions, and when core barrels were manufactured which could take good samples of reservoir rock.

The art was further advanced by the introduction of modern instrumental well-logging systems. These tools, for the first time, furnished the engineer data on what was happening in oil wells; and permitted hypotheses of reservoir behavior to be tested in the field. These studies led to the exposition of the basic principles which govern the movement of oil and associated fluids through the reservoir rock and the well bore to the surface, and an understanding of these principles enabled engineers to devise means of controlling the energy of the oil reservoir in such a way as to improve recovery.

Author is coordinator of production research, Esso Research & Engineering Co., New York. Paper presented at annual meeting, A.P.I., San Francisco, November 16, 1955, under the original title, "Production Technology and Recoverable Oil Reservoirs."

Two ways to go . . . The technology of reservoir engineering has developed along several lines. One of these is the conservation of the natural energy of the reservoir, brought about through more efficient and more economical well spacing, control of the rate of production from fields and wells, and elimination of the production of excessive quantities of gas and water. Another line along which progress has been made is in the mechanics of well completion and repair. Improved methods and materials have gone far to eliminate pipe failures and faulty cementing jobs, which cause serious underground waste of oil.

Methods of well completion, well repair, and workover have been developed which make it possible to control better the movement of fluids in the reservoirs. New processes for well stimulation have opened to production many reservoirs that otherwise would be too tight to be produced at economic rates. Another field in which progress has been made is in the development of processes for supplementing natural reservoir energy by injecting gas or water into the reservoir.

How effective it has been . . . Hardwicke recently estimated[1] that modern producing methods, as practical under the regulations of state conservation agencies, have resulted in an increase of 50 per cent in the recoverable reserves. Although there may be room for some doubt as to the exact amount by which technology has increased the recovery of oil, there can be no doubt that the figure is very large, or that further improvements will lead to additional increases in the recoverable reserve.

As new reserves become harder to find, interest is increasing the recovery from known oil fields has become keener, and some significant studies have been made as to how much oil present producing practices will leave in the ground. Fancher, in a recent survey[2] of the Texas fields, estimated that the fields of that state, which have produced about 14.8 billion barrels, have remaining reserves of about 26.2 billion barrels, 10.5 billion of which are to be produced by secondary recovery.

Fancher, in his report, defines secondary-recovery reserve as "the difference between the oil physically displaceable by fluid injection and the estimated primary reserve," pointing out that the definition does not consider economics. Tests on cores generally show that the oil physically displaceable is a much higher fraction of the original oil than Fancher's figures indicate; and suggest that a better definition of the secondary-recovery reserve would be the amount of oil, in excess of the estimated primary reserve, which would be recoverable under favorable economic conditions by the intensive application of the best-known recovery methods.

Fancher's report suggests that the recovery of the State of Texas will average about 43 per cent. Much of this oil was produced by wasteful practices, and much of the unrecovered oil lies in reservoirs of unfavorable characteristics, so that the oil recoverable by good modern production practice from good reservoirs must be far higher than the 43 per cent indicated as the average past performance for this great producing area.

Good data needed . . . It is interesting to note many of the fields expected to yield a high percentage of the oil in place are those on which good data are available and which have been subject to good engineering analysis. Many of the fields in which the recovery is expected to be low are older fields for which good reservoir data are lacking. This may be one reason why Torrey's

compilation of estimation indicates a lower percentage of recoverable oil for the entire United States than Fancher does for Texas.[3]

Torrey's figures show 272 billion barrels as the original oil content of known commercial reservoirs; whereas the sum of past production, primary and secondary reserves, is given as 105 billion barrels, leaving 167 billion barrels of oil unproducible by today's methods. Torrey and Fancher define secondary reserves in the same way, and it is believed that the same comment on the definition applies to both discussions.

There is a chance of considerable error in any comprehensive survey of the nation's oil reserves, which would necessarily include so many fields on which good data are not available. A study of the performance of fields on which good data are available might give a better idea of how much oil is being left in the ground by good modern practice.

In view of the individualistic nature of oil reservoirs, it is not surprising that some oil fields, produced without regard to conservation practices, have still yielded very high recoveries. Such fields were exceptional, and 25 years ago most oil was produced under methods which would yield a third, or less, of the oil in place.

One example of an old field which yielded high recovery is Wortham. This was a narrow fault-line field producing from the Woodbine sand in East Texas. The relatively small oil reservoir was subjected to a powerful water drive from the large Woodbine aquifer with which it was connected, so that, in spite of close well spacing and rapid production, the water drive was effective and resulted in the displacement of a very large fraction of the oil. Recoveries from this area have been estimated at over 1,100 bbl. per acre-foot.[4]

Another example is Oklahoma City field[5] which was developed and produced through its flush stage at a time when state conservation commissions were just beginning to exercise some control over petroleum productions and before any effective control was possible in a field developed under such intensive competitive conditions as prevailed in Oklahoma City. Here the high recovery, estimated at over 60 per cent of the oil in place, was due to reservoir conditions which were extraordinarily favorable for production of oil by gravity drainage.

Drive and drainage . . . Water drive and gravity drainage are two of the most efficient means for obtaining high recovery today, and a major contribution of modern reservoir engineering has been to show how these processes can be made effective in fields in which natural conditions were far less favorable than in Wortham or Oklahoma City.

A recent example of good conservation practices is the operation at Elk Basin, were pressure maintenance by gas injection is estimated to be capable of recovering over 60 per cent of the oil in place.[6] Had the recovery methods used at Oklahoma City been used at Elk Basin, the recovery might have been cut in half.

Another example is the Kelly-Snyder area[7] where, even from an irregular reef reservoir, it is conservatively estimated that more than 50 per cent of the oil in place will be recovered by modern producing methods made possible by unit operation. By the application of good reservoir engineering, recoveries of 60 to 80 per cent are expected in many of the important fields recently developed in western Canada.

East Texas field, and many of the prolific fields of the Gulf Coast, may be cited as other examples of fields that will produce between 50 and 80 per cent of the oil originally in place. Indeed, the majority of major fields in which the pressure has been maintained reasonably close to the original pressure, either through conservation of the natural reservoir energy or through injection of gas or water, have recovered over 50 per cent of their oil in place. Such recovery under efficient practice may be contrasted with the recovery of about 20 or 25 per cent commonly expected from reservoirs depleted under dissolved-gas drive.

In fields that have been produced by inefficient primary-recovery methods, secondary-recovery operations can be used to obtain substantial additional production. Ultimate recovery by primary and secondary operations of 40 to 60 per cent is common under good secondary-recovery practice. Secondary recovery in depleted reservoirs is generally not as efficient as the equivalent fluid injection carried out as a pressure-maintenance operation in a new field, although there may be exceptions to this rule.

Practical considerations . . . There are often practical considerations which dictate the use of less efficient reservoir mechanisms; there are still oil fields being depleted under the inefficient mechanism of dissolved-gas drive. One of the most common of these considerations is the application of efficient reservoir-engineering methods generally requires unitization of the pool, or operation under conservation regulations that have substantially the same effect as unitization.

In some oil fields in flush production it is virtually impossible to reconcile the interests of the various property owners so as to permit the adoption of a program for development and operation which would lead to maximum recovery from the whole field. When fields approach depletion under dissolved-gas drive, and it becomes apparent that the only way the production can be extended economically is through a secondary recovery under unitization, the property owners can often reach a satisfactory unitization agreement, but the arrangement of such agreements is sometimes extraordinarily difficult.

There may be good economic reasons for not adopting pressure-maintenance operations in the early life of some fields. In the case of smaller fields with reservoirs of poor quality, rapid production at the expense of high recovery may offer an acceptable payout on the investment in the properties, whereas pressure maintenance may result in too slow return of the capital tied up in the operation. Finally, there are, in many cases, technical reasons why pressure-maintenance operations are unattractive in some fields.

Pressure maintenance requires a continuity of the producing zone and proper location of producing and injection wells. In smaller, less prolific and more irregular reservoirs, it is not always possible to ascertain the necessary continuity. In some areas the reservoir rock is so tight that it is not possible, under ordinary operating conditions, to drive the injected fluid through it. Then, there are many reservoirs in which the viscosity of the oil is so high that only a small percentage of it can be displaced by the flow of any reasonable quantity of gas or water through the rock.

Oil recovery in some cases may be very high, possibly in the neighborhood of 80 per cent in prolific fields produced under the best practice; or in others very low, in the neighborhood of 20 per cent for those fields in which the qualities of the reservoir rock and oil are inherently unfavorable, or for those where economic conditions or other practical considerations discourage the use of best conservation practices.

Recoverable oil . . . The oil recovery, expressed in a percentage of that originally in place, is a convenient measure of efficiency; but in order to evaluate an operation properly, the amount of unrecovered oil must also be considered, as Muskat has done in a recent discussion of this problem.[8] One of the well-established principles of fluid flow through the reservoir rock is that oil must be present in a certain minimum

TABLE 1

	A	B	C
Porosity, per cent	25	20	25
Connate water, per cent	15	45	20
Residual-oil saturation, per cent	15	20	15
Formation volume factor	1.20	1.30	1.10
Oil in place, stock-tank barrels per acre-foot	1,375	660	1,410
Expected recovery, stock-tank barrels per acre-foot	1,050	350	500
Unproduced oil, stock-tank barrels per acre-foot	325	310	910
Residual oil, stock-tank barrels per acre-foot	240	240	260
Limit on unproduced oil available by conventional means, stock-tank barrels per acre-foot	85	70	650
Per cent recovery	76	53	35

concentration in order to flow at all.[9]

This amount of oil is sometimes referred to as the residual saturation, sometimes as the equilibrium saturation. It represents the minimum amount of oil required to establish continuous flow channels to the well bore through which the oil may move. Quantitatively, it depends upon the properties of the reservoir rock and the contained fluids, but ordinarily it amounts to a few hundred barrels of oil per acre-foot.

This residual oil cannot be recovered by conventional techniques of primary and secondary recovery, which for the purpose of this paper are defined as those producing methods which do not involve substantial physical changes in the properties of the fluids in the reservoir. Thus, the unproduced reserve is classified into two parts: one, the oil over and above the residual oil, which is susceptible, physically is not economically, to recovery by conventional methods; and the other, the residual oil itself, which must be produced by a new recovery method if it is to be produced at all.

This point may be illustrated by some numerical examples (Table 1) for three hypothetical reservoirs whose assumed performance is fairly close to the actual results being obtained from some real fields.

Examples . . . Example A exemplifies some of the large prolific reservoirs of exceptionally good quality; Example B is typical of a poorer quality of reservoir produced under pressure maintenance and careful reservoir control. Note that although the recovery from Reservoir B was only one-third that from Reservoir A, there was less unproduced oil in Reservoir B than in Reservoir A.

This is cited to show that per cent recovery is often a poor index to the efficiency of a producing operation. Reservoir C is typical of some reservoirs depleted by dissolved-gas drive, in which case the reservoir would be a good prospect for secondary recovery. It also indicates what might be expected in some heavy-oil fields, in which case conventional secondary-recovery methods may not be applicable.

The question of how much oil is being left in the ground by modern methods might be reexamined in the light of the classification of unproduced oil into a component producible by conventional methods, and a component which will require a new technology to produce. This requires a detailed, field-by-field study for which adequate data are not available. However, a rough estimate might be made which is compatible with the data presented in F a n c h e r's comprehensive study.[10]

Oil present in all the known fields of Texas before exploitation is estimated at 94.4 billion barrels, of which about 45 per cent will, according to Fancher, be producible by primary and secondary methods. Allowing for the fact that some oil was irretrievably lost by mechanical failures or by the wasteful production practices of the past, the amount of oil left, by present practice might be about half of that originally in the reservoir, leaving about half which might be exploited by improved technology.

From laboratory data, it may be roughly estimated that the residual-oil saturation is about a quarter of the original oil in place, which, if it is to be recovered at all, will have to be obtained by some new process which involves more than simple fluid injection. This, therefore, w o u l d leave roughly another quarter of the original oil which might conceivably be attained by improvements in conventional methods.

Many of the larger and more important fields in the United States discovered since 1930 are probably leaving little more than the residual oil unproduced. Most of the oil which will not be produced under current practice is in older fields; in small, irregular fields; in the fields producing from inferior reservoir rocks; and in the fields producing viscous heavy oil.

In some of these fields, the best modern practice is not followed, either through lack of economic incentive or because of the difficulty of carrying out a suitable unitization program. In others, the cost of getting and analyzing good reservoir data, and the high cost of some effective producing methods when applied on a small scale result in leaving some oil which is theoretically recoverable.

Here, in these inefficiently operated fields, advancements in production technology will provide excellent opportunities to increase recovery, even by conventional methods. Some of the developments that are needed, which are the subject of active research in laboratories throughout the country are:

1. Better methods of determining the amount of oil in the reservoir, which may include better methods of coring and core analysis, improved well-logging instruments, and new methods of well testing and analyzing well-test data.

2. Better methods of predicting the effect of natural forces such as water drive and gravity drainage, which will come from better methods of analyzing reservoir performance.

3. Better methods of analyzing fluid-injection operations, which will develop from improved understanding of the effect of such factors as reservoir irregularities, injection rate, injection-well patterns, and sections most suitable for injection and production.

4. Better methods of determining the configuration of the reservoir, perhaps from well-test data, possibly by geophysical methods, which would permit wells to be located properly with respect to the structure, and would result in more efficient patterns of fluid flow in the reservoir.

5. Better methods for well completion, well repair, and well stimulation, which will provide the necessary mechanical tools for reservoir control.

Developments such as these will not only extend the usefulness of present production methods so that the economic recovery may more closely approach the limit set by the laws of fluid mechanics, but they will be equally useful to the engineer in his attempt to meet the challenge which he now faces, that of capturing the remaining oil not available through conventional methods.

Recovering Residual Oil

To get at the residual oil, it is necessary to bring about significant physical changes in the reservoir fluids other than those which occur during normal depletion. Several promising approaches have been demonstrated in the laboratory and are now being tested in the field.

It has been shown in the laboratory that some of the residual oil can be produced through the reduction of the interfacial tension between oil and water by surface-active agents.[11] Many field tests of this method have been made, but the results so far have not conclusively demonstrated the economic advantages of the process.[12]

The use of solvents in various ways

is also being seriously studied,[13] and laboratory tests show that almost complete recovery is theoretically obtainable. Several methods of applying solvents in the field are being tested. One of these, using L.P.G. components to enrich injected gas, has given results which suggest that under favorable conditions recoveries of the order of 80 per cent might be obtained in practice.[14]

The possibility of using non-hydrocarbon solvents such as carbon dioxide is being studied.[15] Vaporization of a part of the residual oil by gas injection at high pressure has been proposed,[16] and is now being tested in the field.[17] One of the most interesting techniques recently proposed is the recovery of oil by condensing gas drive.[18]

Several thermal methods of increasing recovery are being investigated, one of the most interesting variations being in situ combination.[19,20] Small field tests have been run on this method, and recently plans for tests of considerable significance have been announced by General Petroleum Corp.,[21] and Standard Oil Co. of California.[22]

Lab tests and studies . . . Laboratory tests and theoretical studies have demonstrated that any of these new recovery methods are capable of removing almost all of the oil from the rock through which they are operative. Only two barriers keep them from being widely used today. One of these is the physical problem of controlling the fluid distribution in the reservoir in such a way as to operate throughout the productive section of highly complex and irregular reservoirs. To learn something about this problem is one of the objects of the field tests now under way.

The other is the problem of economics. It is not surprising that each of the new methods proposed requires expenditures of considerable size, whether they be for chemicals, for carrying a large inventory of solvents, for fixed charges and operating costs of large compressor plants, or for fuel. The new methods are expensive, and they must compete with conventional producing methods.

The worth of a new method is measured not by the average cost of production, but by the increment cost of the additional oil produced. Inasmuch as a large part of the original store of oil in the ground can be produced at moderate cost by conventional methods, a new method must pay for itself by operating on reservoir rock which is lean in oil

Furthermore, the new method must produce a significant physical change in the properties of the reservoir fluids, which is an expensive burden not carried by conventional methods. These conditions impose an economic handicap which is very difficult for any new method to overcome.

When to use . . . For these reasons, the new recovery methods, as presently conceived, are unlikely to be applied universally. On the other hand, there undoubtedly will be fields where circumstances will permit the new methods to be used economically to obtain very high yields of oil.

One type of field which probably can be economically produced by thermal methods or by solvents is that with heavy, viscous oil where water injection leaves a substantial amount of oil unproduced. Another case where a new method might be advantageously employed is that of a field located in an area where substantial quantities of L.P.G. are available at low cost.

Certain features of the new methods will gradually be incorporated into conventional practice to develop a technology which will give far greater yields of oil than present methods do, but which may fall short of the ideal of recovering 100 per cent of the oil in the reservoir.

Undoubtedly, a larger percentage of the oil would be economically recoverable if the United States were dependent for its liquid fuel upon the residual oil in known commercial reservoirs. This is not the case. The geologists have shown a remarkable ability to discover new reserves of oil. As production technology improves, fields of poorer quality and in less favorable areas can be exploited.

And finally, there are the oil shales and other nonpetroleum sources of liquid fuel which can be made available at a cost which, although it is higher than the cost of petroleum fuels, would not be an excessive burden to the country's economy.

Summary

Technological developments over the past 25 years have led to improved production practices which are capable of capturing a far higher percentage of the oil originally in place than former methods. At the present time, about half the original oil is being recovered, but rapid technical progress is being made, and even greater recovery is to be expected in the future.

Radically new methods are being developed which will add to the recoverable reserve in many fields, but continual improvement along conventional lines may play an even more important part in producing oil reserves that are being left behind today. Although it is probable that methods could be devised to recover practically all of the oil in a reservoir, economic considerations make it unlikely that such methods will be widely practiced in the foreseeable future.

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EDITOR'S NOTE . . .

"Should we use explosionproof electrical fittings here or not?" That's a vital question to designers, whether it applies to refineries, natural-gasoline plants, pipeline pump stations—or any other petroleum-industry installation, large or small, where electrical equipment is used.

This article gives a simple means of answering that question. It's written for both the design engineer and the maintenance foreman. The method given won't be difficult for either to understand and use.

In the past there have been guesses, general industry practices, user-company policies, and designing-company standards to guide the final classification of any plant area. But in this business, guesses or general rules are not enough. The stakes are too high. Needless danger may be involved on one hand, or excessive expense on the other if the wrong classification is made and the wrong equipment used.

That the methods used haven't been consistent within themselves is evident from a look at almost any plant in the country. Explosionproof equipment will be found side by side with open breakers. Or right beside an open-fire heater will be found an expensive explosionproof junction box.

Obviously something needed to be done. An A.P.I. subcommittee started working on the problem in 1951. The accompanying article is authored by the chairman of that committee. It explains the background of the problem and the concepts involved, and gives simple, graphical methods of deciding whether any given area should be classed as hazardous or not for the purpose of choosing electrical equipment. Other important points are covered—determining outline of a danger area, classing it as to degree of hazard, etc. It's the type of article that's important to a great many people —from wire twister to head electrical engineer.

When Is an Area Hazardous?

Here's how to classify it for electrical installations

by L. M. Goldsmith

IT would not be fair, in the author's opinion, to discuss current practices in classified areas for electrical installations without first showing electrical engineering's contribution to oil. The best example, we believe, is in the petroleum refining industry.

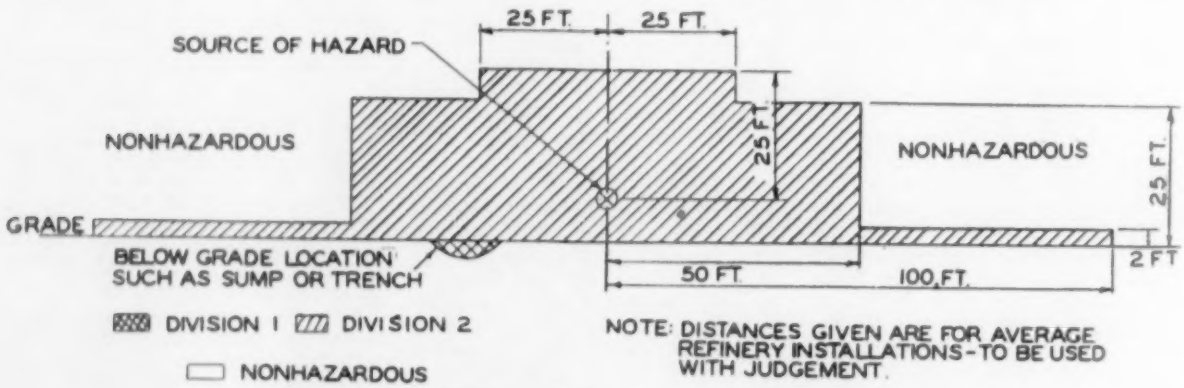
Forty years ago, there were 674,840 bbl. of crude oil per day charged to what were then called "stills." The consumption of electricity was 1 kw.-hr. per bbl., or 674,840 kw.-hr. were consumed daily. Today, with 6,930,000 bbl. charged to refining equipment per day and 4.85 kw.-hr. per bbl., the total daily consumption for the petroleum refining industry alone is 33,610,000 kw.-hr. This is an increase in the use of electricity in the industry of 5,000 per cent in 40 years.

Author is with Atlantic Refining Co., Philadelphia. Paper presented at the A.I.E.E. Electrical Conference of the petroleum industry, September 12, 1955.

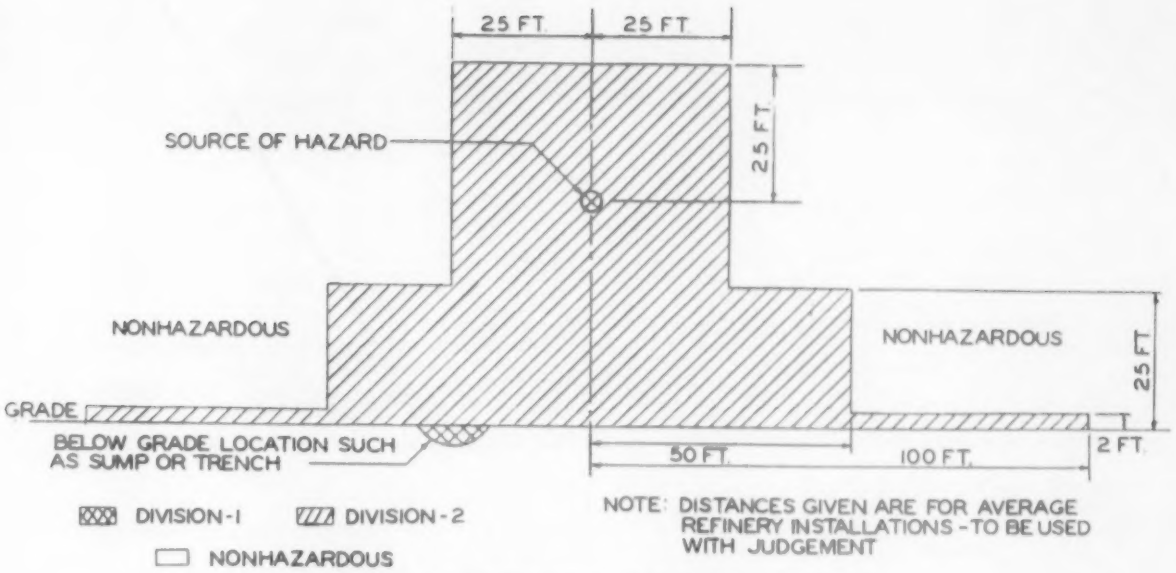
The rapidly increasing use of electric power in the petroleum industry and the relatively higher costs of special equipment and skilled labor emphasize the need for clear understanding of the requirements for safe, economical design. The presence of combustible materials introduces problems that are not met in most electrical installations.

Special precautions are required to insure that electrical installations for the petroleum industry do not create fire and explosion hazards. This concern over the fire and explosion aspects has tended to obscure the fact that electrical installations present other types of hazards of an equally serious nature. In the oil industry these hazards are: (1) fire and explosion, (2) electric shock, and (3) power failure.

Equipment characteristics . . . It is difficult and pointless to attempt to say which is number one. All are serious. A properly designed electrical installation recognizes and protects against all



FREELY VENTILATED process area, source of hazard near grade. Fig. 1.



FREELY VENTILATED process area, source of hazard above grade. Fig. 2.

hazards. Unfortunately, no single type of electrical-equipment enclosure is best in all respects. General-purpose-type equipment, for instance, is adaptable to the finest in relaying and automatic controls and thus is the best insurance against a power failure.

But when considered from the point of view of fire and explosion hazards, general-purpose equipment is totally inadequate. On the other hand, explosionproof equipment correctly designed and manufactured, properly installed, and carefully maintained is best against the dangers of fire and explosion. But explosionproof equipment does not have the protection against shock provided by the safety interlocks, the isolating barriers, the drawout features, and the working clearances found in general-purpose equipment.

General-purpose equipment is inexpensive. Explosionproof equipment is expensive. To use explosionproof equipment where it isn't necessary is spendthrift. To use general-purpose equipment where it isn't safe is foolhardy.

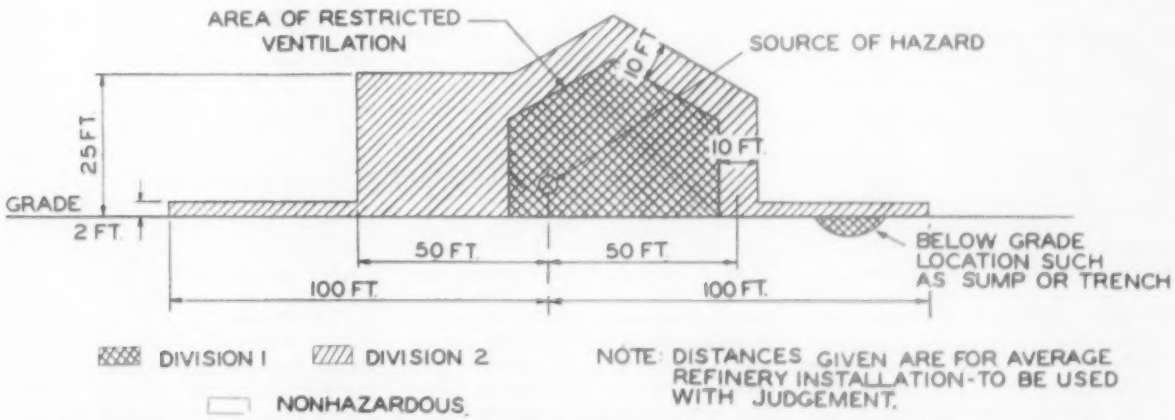
These are only a few of the advantages and limitations of each type of equipment. The safest installation takes full advantage of the best features of each type. However, this approach is possible only if the degree and extent of the areas of hazard are clearly defined.

What can be done? . . . It is elementary that the safest thing to do would be to eliminate electrical installations in hazardous areas. This, of course, is not practical. The next best thing is to limit electrical installations in hazardous areas to only those that cannot reasonably be made elsewhere. This can be practiced when the areas of hazard are accurately defined.

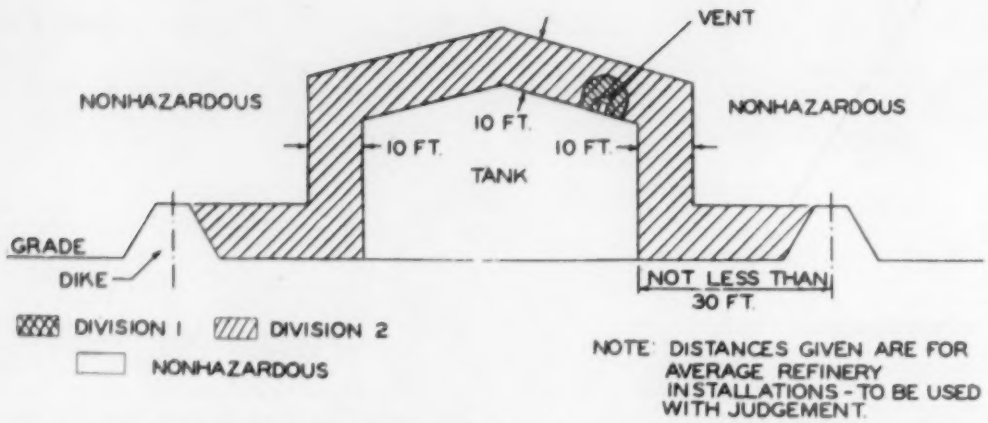
There are many practical reasons why electrical installations, even though the construction is fully explosionproof, should be held to the minimum in hazardous areas. From personal observation of plants on an industry-wide basis, the author can give countless examples illustrating the difficulties of adequately policing extensive electrical installations in hazardous areas.

Such things as explosionproof enclosures that are in service with the cover bolts loose or missing, or sometimes even with the cover gone altogether, are not unusual.

Everyone is familiar with the adaptor or cheater that most mechanics carry to convert explosionproof receptacles to the ordinary garden-variety household type. This is common during refinery-unit shutdowns and in many, many cases is allowed to remain when the unit goes on stream again. The use of such devices is widespread. In fact, this questionable art has developed to



PROCESS AREA with restricted ventilation; apply above dimensions or 10 ft. beyond perimeter, whichever is greater. Fig. 3.



TANK FARM: for floating-roof tanks, area above tank roof and within shell is classified Division 1. Fig. 4.

the point where cheaters with as many as three outlets on the general-purpose end are now in circulation.

Pressure-ventilated switchrooms have their own special brand of problems. Open doors and windows, inoperative blowers, and closed dampers are the prime offenders. Changes or additions to the plant that jeopardize the "safe" source of the air for ventilation are another headache.

A close inspection of almost any refinery would probably uncover similar examples. Such things point up the fact that no matter how carefully an installation is designed and constructed, the safety features are easily nullified. Therefore the safest approach is to minimize electrical installations in hazardous areas.

Inconsistencies . . . It is astounding how much confusion, disagreement, and inconsistency has surrounded the problem of classifying locations as Division 1, 2, or nonhazardous. Equal chaos prevails on determining the extent of a hazardous area. Opinions have ranged from the "everything within the fence" philosophy to the 25-ft. rule.

Disagreement and inconsistency between different organizations or different geographic areas is at least understandable. Inconsistencies within the same organization resulting in contradiction on the same installation are beyond explanation. Yet they are common. Everyone has seen a lineup of explosionproof switchgear within a few feet of a general-purpose switchgear assembly. Obviously one or the other is a misapplication. Either a lot of money was wasted on explosionproof switchgear or a very unsafe installation of general-purpose switchgear was made.

Similarly, we all have seen identical explosionproof air circuit breakers installed side by side with one breaker equipped with conduit seals while the other one has no seals at all. Which one is correct? Was money wasted on explosionproof breakers, or was a hazard created by omitting the seals on the one breaker?

A.P.I. Works on Problem

Because of the importance of accurate and reliable classification of hazardous areas, both from the standpoint of safety and first cost of installations, and because of the obvious lack of any recognized sound basis for making such classifications, the American Petroleum Institute became interested in this problem.

In 1951 the A.P.I.'s subcommittee on electrical equipment, under the chairmanship of the author, was asked to undertake a project intended to develop a sound basis and understandable procedure for determining the existence, classification, and extent of hazardous areas in petroleum refineries.

This work culminated early in 1955 with the publication of A.P.I. Recommended Practice RP-500, a Classification of Refinery Areas for Installation of Electrical Equipment. It is believed that the recommendations contained in RP-500 will, if applied with intelligence, lead to accurate and consistent classification of the degree and extent of hazards. This in turn will provide a reasonable and consistent basis for selecting the safest equipment and installing it in the safest location. For perhaps the first time, the industry will get the maximum in safety for its effort and money.

The first step in developing RP-500 consisted of a survey of the practices of the refining companies participating in A.P.I. At that time it was hoped that such a survey would indicate that a substantial majority of the industry was following identical practices. The fact that a majority followed a particular practice would be taken as evidence of its soundness and thus the job could be reduced to one of determining and formalizing the practice of the majority.

The first survey indicated total disagreement. A second survey was made, but the results were the same.

Start from scratch . . . About this time, it became obvious that the only thing to do was to start from the bare fundamentals in an attempt to reason our way to the correct answer, of course tempering the reasoning with the judgment and experience of the committee members.

Such things as the conditions necessary to create a hazard, the sources of hazard (including types, sizes, flash points), and the factors affecting the extent of a hazardous area (such as ventilation, quantity of inflammable material released, air currents, density of inflammable material, etc.), were considered in great detail.

It soon became obvious that to pin point the factors entering into each installation would result in an unwieldy and completely unworkable solution. The simple and straightforward solution was thought to be of utmost importance. In other words, unless the recommendations could be understood by the average electrical man and used with a reasonable amount of time and effort, the recommendations would be of little value.

Accordingly, we decided a broad approach was the proper one. That the recommendations should be made sufficiently conservative so that variations in small details would not alter the soundness of the solutions. So much for the background material.

A.P.I.'s RP-500 . . . Now let's have a look at RP-500 and see what it's all about. At the outset, it should be realized that this is not a legal document, merely a recommended practice. Also, it is a series of recommendations that

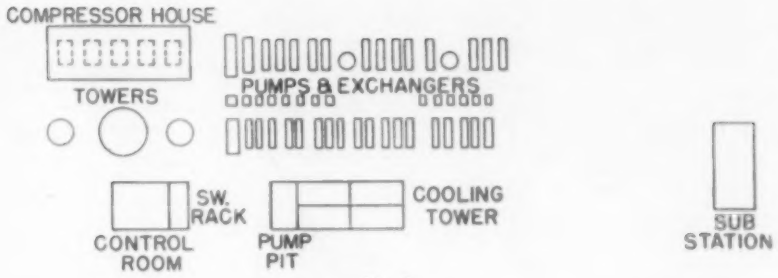


Fig. 5.

STEP 1—Affirmative answer to any of the following indicates the existence of a hazard:

Is the presence of flammable liquids or vapors having flash points less than 70° F. likely? No

Are any flammable liquids or vapors having flash points under 200° F. likely to be handled, processed, or stored at temperatures above their flash points? Yes

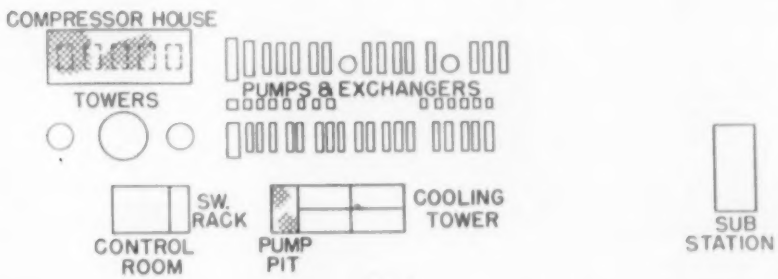


Fig. 6.

STEP 2—Affirmative answer to any of the following indicates existence of Division 1 location:

Is a hazardous gas or vapor concentration likely to exist in the air under normal operating conditions? No

Would a flammable atmospheric concentration occur often because of maintenance, repairs, or leakage? No

Would a failure of equipment be likely to cause a simultaneous electrical system failure? No

Is the area not freely ventilated and one in which flammable materials are handled in other than tight equipment or containers? Yes, compressor house

Is the area below grade? Yes, pump pit

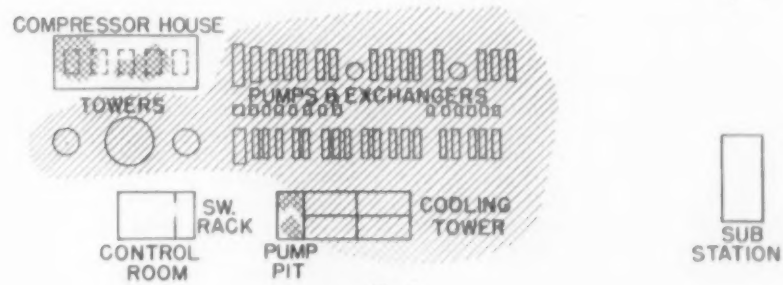


Fig. 7.

STEP 2—Affirmative answer to any of the following indicates existence of Division 2 location:

Is the location freely ventilated and with flammable materials handled in closed systems (other than tight piping systems) from which escape would be abnormal, or stored in other than closed containers? Yes, except compressor house

Is the area next to a Division 1 area, or can vapor be communicated to it through trenches, ducts, etc.? Yes

If positive mechanical ventilation is used, in event of its failure or abnormal operation could a hazardous vapor concentration build up? No

are felt to be adequate for typical or average cases. It is intended that in using these recommendations, sound judgment should accompany the use of this material. Where, in the opinion of the engineer, particular conditions are better or worse than average, then the recommendations of RP-500 should be modified appropriately.

RP-500 is not an attempt to rewrite or otherwise supersede the National Electric Code. Rather it is intended to serve as a supplement. The N.E.C. is quite specific on the type of equipment to be used in hazardous areas. Once the degree and extent of hazard have been determined, there is little difficulty in understanding what the requirements are for equipment.

The real problem is determining the existence, degree, and extent of a hazardous area. The N.E.C. has established certain criteria for making this determination, and RP-500 attempts to apply these criteria to typical oil-refinery installations.

Article 500 of the N.E.C. deals with hazardous areas. It recognizes two types of areas directly and a third by indirection. These areas are:

. . . **Division-1 areas.** The criterion for these locations is that they may be hazardous under normal conditions.

. . . **Division-2 areas.** The criterion for these locations is that they may become hazardous only under abnormal conditions—such as the failure of a gasket, etc.

. . . **Nonhazardous areas.** These are locations that cannot be classified as Division 1 or 2.

The terminology and criteria of the N.E.C. are used in the definitions developed in RP-500.

Three conditions must be satisfied in order to have a fire or explosion. The conditions are:

1. A flammable material must be present.

2. The flammable material must be present in the proper proportions to ignite.

3. A source of ignition must be present.

The first thing that must be done is to decide what is flammable material. RP-500 proposed that materials be judged flammable if they meet the following:

1. Any material being handled, processed, or stored at a temperature above its flash point.

2. All materials with a flash point less than 150° F.

The basis for the first rule is obvious. The second rule is based on conservative judgment backed by the combined experience of the sponsors.

Whether a flammable material can be present in proper proportions to ignite leads to endless complications. This report assumes that if a flammable material is present, it will be in a state to ignite. This assumes the worst and thus is conservative. Generally if flammable materials are handled in an area, there is a possibility of their getting into the air either normally or as the result of some abnormal occurrence. At this point "abnormal" must

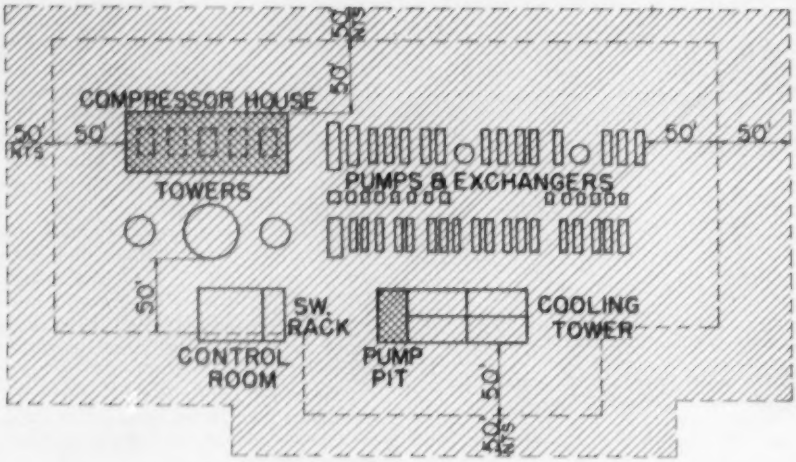


Fig. 8.

STEP 3—Determination of the extent of the hazardous areas:

The extent of a classified location is determined by applying the recommended distances given in Fig. 1 through Fig. 4.

Within an area extending 50 ft. from all equipment the vertical extent of the Division 2 location is 25 ft. above grade or equipment, whichever is higher.

Within the outer 50-ft. band the vertical extent is 2 ft. above grade.

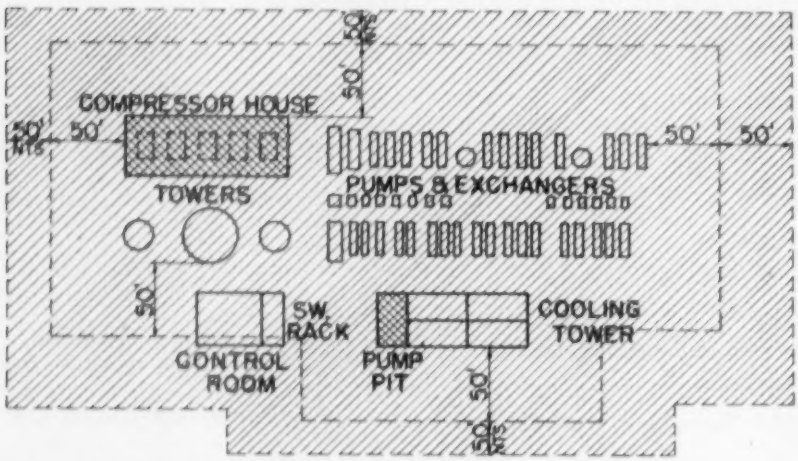


Fig. 9.

STEP 4—Determination of proper N.E.C. grouping of atmospheric mixtures:

As only hydrocarbons commonly encountered in refineries would be present the proper N.E.C. atmospheric grouping is Group D.

be defined. Abnormal is used here in a limited sense. It is intended to cover those things that can go wrong short of a major catastrophe.

It is generally recognized that it is not possible to protect against such extremes. Thus, except for a few special cases which are spelled out in RP-500, any location in which a flammable material is handled, processed, or stored is hazardous.

As stated previously, the N.E.C. criterion for Division 1 is whether the location can be hazardous under normal conditions. For Division 2 the criterion is whether the location can be hazardous only under abnormal conditions. "Normal" does not necessarily mean the situation that prevails when everything is working properly. For instance, an operation might be so sensitive to control that frequent operation of the relief valves occurs. This would be considered "normal" and if the valves might release flammable material to the atmosphere, the location would be classed as Division 1. On the other hand, if the operation of the relief valves occurred infrequently under unusual conditions, it would not be considered "normal." Similarly there are cases where frequent maintenance and repair are necessary. This would be viewed as "normal" and if flammable material might be released as a result of the maintenance, the location would be Division 1. However, if repairs were not usually required between turnarounds, the need to do repair work would not be considered "normal."

The remainder of this article will go into details on the hardest part of the problem—determining the extent of a hazardous area.

What Is Hazardous Area

The hardest part is to arrive at a basis for determining the extent of a hazardous area. Perhaps a good beginning is to start with the fact that hydrocarbons are generally heavier than air. Their behavior in air is somewhat like a liquid in that they tend to sink to the ground, billow along it, and seek and settle in low spots.

This liquid-like behavior leads to several conclusions:

1. In the absence of walls, enclosures, or other barriers, and in the absence of air currents or similar disturbing forces, it must be assumed that a vapor will travel equally in all directions. Thus, if the source of hazard were a single point, the area covered by the vapor would be a circle.

2. The locations most likely to be hazardous are below grade. Those at grade are next most likely. As the height above increases, the likelihood of hazard decreases.

3. Safe distances or clearances in the vertical direction are much less than in the horizontal direction.

Another concept that must be understood is that there is always a twilight zone between a Division 1 (normally hazardous) location and a nonhazardous location. Obviously one side of an imaginary line cannot be normally hazardous and the opposite side never be hazardous. There has to be a zone that could be hazardous under abnormal conditions. These conditions might be unfavorable air currents, an abnormally large release of flammable material, and so on.

It is quite easy to acquire an exaggerated idea of the extensiveness of Division 1 locations. The probable reason for this misconception is that it is

very hard to keep from thinking in terms of what could happen if a major piece of equipment let go. It takes constant mental discipline to think in terms of what can happen under **normal** conditions. Surely the failure of a major item of equipment is not a normal condition. Such an occurrence is abnormal in every sense of the word.

This does not mean the abnormal is not a consideration in the over-all picture. That is the significance of Division 2—the twilight zone that always exists between a source of hazard and a nonhazardous area.

Correctly evaluated, a refinery installation in a freely ventilated area will be found to be a multiplicity of Division 1 locations of extremely limited extent. What releases flammable materials under normal conditions? Probably the most numerous of offenders is the packing gland. RP-500 concludes that although Division 1 locations may exist around packing glands, in freely ventilated areas the extent of the hazard is so small it may be ignored. Glands located where the free dispersion of vapors is restricted are different. Here there is the chance of the flammable material accumulating, and the whole area of restricted ventilation should be classified Division 1.

Clearances recommended in RP-500 are presented graphically. These recommendations have been based on a careful weighing of all pertinent factors in the light of the available experimental data and the experience of a large segment of the oil-refining industry.

Figs. 1 and 2 cover refinery-process areas with unrestricted ventilation where flammable materials are handled only in closed systems. It will be seen that the extent of Division-1 locations is negligible for above-grade locations. All areas below grade are considered Division 1. The extent of Division-2 locations may be determined by applying the clearances given in Figs. 1 and 2.

Fig. 3 applies to refinery process areas with restricted ventilation. Note that in this area the entire area of restricted ventilation is classified Division 1. A buffer zone or area classified Division 2 surrounds the Division-1 area. Horizontal and vertical dimensions are given for determining the extent of the Division-2 area.

Fig. 4 applies to storage tanks and indicates that the only Division-1 areas are the interior vapor space of the tank and the exterior area in the immediate vicinity of the vents. Clearances both horizontal and vertical are given for determining the extent of the Division-2 area which is indicated to surround the tanks. Note the warning regarding high filling rates or blending operations involving liquids with flash points of 70° F. or below.

National Electrical Code Article 5,125 provides a specific classification for loading racks and gives clearance distances for determining the dimensions of the classified area. Thus RP-500 recommends Article 5,125 be used when dealing with loading racks.

RP-500 contains a four-step procedure for classifying refinery locations. The steps, in the order in which they are taken, are: (1) for the purpose of establishing the existence of a potential hazard; (2) for determining the degree of potential hazard; (3) for determining the extent of hazardous area; and (4) for determining the N.E.C. grouping of the atmospheric mixture. The first two steps consist of a series of questions; the third step concerns the application of Figs. 1 through 4; and the fourth step involves checking the flammable material in question against the N.E.C. grouping.

By way of illustrating the use of this procedure, consider Fig. 5, which is a typical refinery unit. The lower portion of the figure contains the questions making up Step 1. Since the answers are affirmative, we conclude that a potential hazard exists. Fig. 6 is the same block plan as Fig. 5 except the questions making up the portion of Step 2 intended to test for Division 1 are shown.

This operation indicates that Division-1 hazards exist in the compressor house and cooling-tower pump pit. These areas are double crosshatched to indicate Division 1.

Fig. 7 covers the remaining operation of Step 2, which is designed to test for Division 2. Based on the answers to these questions, it is determined that the outdoor process area should be classified Division 2. These areas are single crosshatched accordingly. Note that the extent of the Division-1 and Division-2 areas is indefinite at this stage as indicated by the irregular perimeter of the crosshatching.

Step 3 is used to establish the extent of the classified areas and Fig. 8 illustrates this operation. As instructed in Step 3, the clearances given in Figs. 1, 2, and 3 have been applied with the result that the extent of the Division-2 areas is as indicated by the single crosshatching, while the double crosshatching indicates the extent of the Division 1 areas. Note that the substation, which is made up of general-purpose equipment, is located outside the limits of the Division 2 areas, while the switch rack, which is made up of explosionproof equipment, is located next to the control house, which is well within a Division-2 area.

Fig. 9 is a continuation for purposes of illustrating Step 4. Since the flammable materials in this process which might create a hazard are hydrocarbons commonly encountered in refineries, the proper N.E.C. atmospheric grouping is Group D. Thus, by these four steps, the area has been completely classified as to degree, extent, and group.

In conclusion, we believe RP-500 provides a sound and practical basis for accurately and consistently classifying hazardous areas in refineries. However, this is by no means the end of the road. It is expected that RP-500 will require revision periodically as experience is acquired in its use.

Another problem that will always be with us regardless of how proficient we become in classifying areas is that of making sure an installation is put in as designed. Designs must be executed exactly and construction supervisors and inspectors must be given a better understanding of why this is important.

Another phase that needs attention is the lack of equipment designed for Division-2 locations, and the application of presently available materials and equipment not now accepted for Division-2 installations.

An example of this is found in wiring methods. One of the greatest hazards in the use of conduits is the passage of gas through the conduit from a hazardous to a nonhazardous area. This creates a hazard in a supposedly safe location, and affords a means for a flash to be transmitted to hazardous area.

Even though seals are used, their effectiveness is often questionable. The use of mineral insulated and armored cable, though not Underwriters' approved for hazardous-area wiring, would eliminate this hazard. It is suggested that the solutions to these problems are projects the A.I.E.E. petroleum industry committee should undertake in the interest of promoting both safety and economy in electrical installations.

Acknowledgment

The author wishes to acknowledge the contribution of the A.P.I. refinery subcommittee on electrical equipment, consisting of the following members, the majority of whom are also members of the A.I.E.E.: E. J. Nopper, Sun Oil Co.; G. A. Hausske, Pure Oil Co.; W. H. Dickinson, Esso Research & Engineering Co.; J. C. Howard, Standard Oil Co. (Ind.); R. P. Howell, Standard Oil Co. (Calif.); E. R. Hoyle, Sinclair Refining Co.; E. W. Kleinpeter, Ethyl Corp.; T. R. Shaw, Phillips Petroleum Co.; F. C. Somers, Atlantic Refining Co.; H. M. Stewart, Humble Oil & Refining Co.; and K. N. Thompson, Socony Mobil Oil Co.

Where to Use Well Logs—and What They Tell You . . .

by Dr. R. W. Hamilton

TABULATION OF USES AND APPLICATIONS OF WELL LOGS

A. **Geological and Exploration Studies**
- Correlation
- Structural studies
- Sedimentary studies
- Water salinity studies
- Porosity and permeability studies
- Finding oil or gas
- Finding water supplies

B. **Reservoir and Engineering Studies**
- Porosity determination
- Water saturation determination
- Permeability determination
- "Pay" determination
- Estimating reserves
- Locating water supplies
- Locating water disposal zones
- Locating suitable underground storage
- Secondary, unitization and repressuring projects

C. **Well Completion and Exploitation**

Depth control for:

Drilling	Casing points	Fracturing
Drill-stem tests	Perforating	Acidizing

- Pool development
- Locating water-producing sections, plug-back points
- Locating gas-oil-water contacts
- Remedial work
- Locating junk in hole
- Exploiting cased-off formations

INFORMATION DESIRED FROM WELL LOGS UNDER LIMITING CONDITIONS

A. **Information Desired from Well Logs**
1. Accurate depths of all beds
2. A log of all lithologic units
3. A log useful for correlation
4. Location of all thin and thick, porous and nonporous beds
5. Location of all thin and thick, permeable and nonpermeable beds
6. Porosity
7. Water and hydrocarbon saturation
8. Permeability
9. Hole diameter, hole declination, dip of beds, location of casing collars, location of cement

B. **Information Must Be Obtained**
1. For thin, as well as thick beds
2. In cased, as well as uncased holes
3. In holes of all diameters
4. In empty holes or in fresh mud, salt mud, chemical mud, oil or oil-emulsion mud

No one logging method provides all of the information, **due to hole conditions and limitations of each method.**

At least 17 logging methods are in vogue today. **Furthermore, one may run at least 23 logging tools in a hole today.**

The 1929 electric log consisted of one resistivity curve.

The 1954 electric log carries a minimum of 4 curves and **could readily display 10 curves.**

WELL LOGGING METHODS AND DEVICES

A. **Conventional Logging Methods**
1. Electric logs:
   - S.P. log
   - Short normal log (2-electrode)
   - Long normal log (2-electrode)
   - Lateral log (3-electrode)
   - Limestone log
2. Radioactive logs:
   - Gamma-ray log Neutron log
3. Pad devices:
   - MicroLog Contact log
4. Focused current devices:
   - Laterolog Guard electrode log
5. Focused current, padded device:
   - Microlaterolog
6. Electromagnetic device:
   - Induction log
7. Hole-measuring devices:
   - Caliper log Section gage log

B. **Specialized Logging Methods**
1. Temperature logs
2. Dipmeter survey logs
3. Directional surveys
4. Casing collar locator logs
5. Acoustic logs
6. Magnetic susceptibility logs
7. Scratcher logs
8. S.P. differential logs
9. Static S.P. logs
10. Resistivity differential surveys

FREQUENTLY EMPLOYED WELL-LOG COMBINATIONS

A. **Electric Log-MicroLog or Contact Log**—Fresh mud
B. **Gamma-Ray, Neutron Log**—Fresh mud, salt mud, oil, empty holes
C. **Gamma-Ray-Laterolog or Guard Log**—Salt mud
D. **Gamma-Ray-Microlaterolog**—Salt mud
E. **Gamma-Ray-Laterolog-Microlaterolog**—Salt mud
F. **Electric Log-Gamma Ray-Laterolog-Microlaterolog**—Salt or brackish mud
G. **Gamma-Ray Neutron-Induction Log**—Oil, resistive fluid, empty holes
H. **Scratcher Log-Induction Log**—Oil, resistive fluid
I. **Scratcher Log-Gamma Ray-Induction Log**—Oil, resistive fluid, empty holes
J. **Electric Log-Induction Log**
K. **Caliper or Section Gage Log**—In conjunction with any combination above

PREVALENT LOGGING METHODS—DATA OBTAINED

Type of Log	Adapted to log in				Log obtains information relating to												
	Fresh muds—conductive	Salt muds—highly conductive	Oil or Oil-Base Muds	Dry Holes—no fluid	Rm-mud resistivity	Thick bed logging	Thin bed logging	Permeable zone location	Porous zone location	Shale or clay content	Indicates caved fmns.	Reflects hole diameter	Ri-resistivity invaded zone	Rt-resistivity noninvaded zone	Rw-resistivity connate water	P%-per cent porosity	S%-per cent fmn. water
S.P.	★	★				★	★	★		★		★			★		
Long normals	★	★				★			★	★		★		★			★
Short normals	★	★				★	★		★	★		★	★			★	
Laterals	★	★				★	★		★	★				★			★
MicroLog	★	★				★	★		★	★	★		★			★	
Microlaterolog	★	★				★	★		★	★	★		★			★	
Laterolog		★				★	★		★	★		★		★			★
Limestone curve	★	★			★	★	★		★	★		★	★			★	
Gamma-ray	★	★	★	★		★	★			★		★					
Neutron	★	★	★	★		★	★			★		★				★	
Induction	★		★	★		★	★		★	★		★		★			★
Caliper	★	★	★	★		★	★				★	★					
Collapsed MicroLog	★	★			★							★					

How to get the most out of Electric and Radioactivity Logs

The author says . . . In this paper we shall discuss the present art of well-log interpretation when tools of the type commonly available are employed. Emphasis is placed on the necessity of planning the mud and logging program so that the greatest advantage is obtained in both the exploration and production phases of operation. In each of these phases it is necessary clearly to understand the problems of the other, to make an effective logging program possible. It is also essential that the appropriate logs be run in order to make an interpretation possible in particular instances.

by C. W. Tittle and M. R. J. Wyllie

Radioactivity or Nuclear Logs

WE shall begin with the nuclear logs since in the present state of their development they are generally regarded as supplementary to electric logs, although they are used frequently without electric logs for purposes of correlation and for the measurement of porosity.

The natural gamma-ray and conventional neutron logs are the nuclear logs in common use, although methods amounting to extensions or amplifications of these tools have recently come into limited use. With the gamma-ray log we locate beds and classify them on the basis of high or low natural radioactivity. With the conventional neutron log we determine the hydrogen content of the various formations. These two measurements together allow us, in most instances, to delineate shales since shales are generally more radioactive than other sedimentary rocks and have hydrogen contents greater than that of most porous rocks. Thus a gamma-ray high and a neutron low together indicate shale.

Porous zones usually show up as intervals of intermediate neutron deflection and low or intermediate gamma-ray intensity. The "clean" formations almost always have a low gamma-ray intensity, the "dirty" ones an intermediate or even high gamma-ray intensity. In the latter case the porous zones are sometimes indistinguishable from shale on all logs. Nonporous zones containing little or no hydrogen such as massive limestone and anhydrite are usually indicated by a low gamma-ray intensity and a high neutron deflection.

* Authors are with Gulf Research & Development Co., Pittsburgh. Paper presented at 1955 Gulf Oil Corp. petroleum engineering conference.

Advantages of the Nuclear Logs

An advantage of the nuclear methods is their relatively great depth resolution of the order of 1 ft. or better with the more modern devices employing scintillation counters as radiation detectors. This not only allows thin beds to be distinguished but makes possible a very precise location of the boundaries between beds whether thin or thick.

Another advantage, and one that is unique in the logging field, is the ability of nuclear devices to operate in cased holes. The accuracy of both gamma-ray and neutron logs is somewhat reduced by casing and cement, but not decisively so. The trend in recent instrumental developments has been in the direction of more reliable logs in cased holes. With the gamma-ray log this has been accomplished by adopting as detectors scintillation counters, which not only are more sensitive than some of the older detectors but are much smaller, thus giving better depth resolution. In neutron logging the effect of the casing has been reduced by employing a radiation detector capable of excluding the "soft" or readily absorbed radiation.

The neutron log can sometimes measure porosity. It really measures hydrogen content, but in those instances where the hydrogen content is directly related to porosity as in clean formations containing oil or water it determines porosity. Even in dirty formations the neutron log can sometimes give a fairly good estimate of porosity.

At depths of less than 5,000 or 6,000 ft. and occasionally at greater depths, neutron log can sometimes detect gas, which shows up as an interval of relatively high deflection. Usually such a deflection would indicate low porosity but since the real interpretation is low hydrogen content the increased deflection can be due to gas in normal porosity. The failure of the neutron log to detect gas in particular instances can be ascribed to various causes, of which the compression of the gas at depth and the masking effect of well-fluid invasion are probably the most important.

1. The Gamma Ray Log

For locating shales the gamma-ray and self-potential logs are frequently used together; shales show up as deflections to the right on both. The S.P. is a more reliable indicator of shales but it suffers from the disadvantage of poor depth resolution unless the resistivity contrast between mud and formations is small. When supplemented by the gamma-ray log, which provides high resolution, it has a wider scope.

In some areas the correlation between the gamma-ray intensity and the shale zones is so good that the gamma-ray log alone is quite reliable for locating the shales. In others, it is sometimes regarded as a substitute for the S.P. when a good S.P. cannot be obtained as in very salty or in oil-base muds. It is not, however, a quantitative

TABLE I—UNITS USED BY SEVEN SERVICE COMPANIES FOR REPORTING GAMMA-RAY INTENSITY AND NEUTRON RESPONSE

	Gamma-ray log		
Company*—	Unit	Conversion factor†	Unit for neutron log
Halliburton	Counts per second	1.0	Counts per second
Lane-Wells Series 200	Standard units‡	208	Standard units‡
Lane-Wells Series 300	Counts per minute	0.018	Counts per minute
McCullough	Micro-roentgens per hour	7.5	Standard units‡
Perforating Guns Atlas	Micro-roentgens per hour	6.6	Standard units§
Schlumberger	Micrograms radium-equivalent per ton	5.9	Counts per second
Welex	Standard units‡	0.018	Standard units‡
Western	Standard units‡	0.018	Standard units‡

*The companies are: Halliburton Oil Well Cementing Co., Lane-Wells Co., McCullough Tool Co., Perforating Guns Atlas Corp., Schlumberger Well Surveying Corp., Welex Jet Services, Inc., and Western Co.

†Approximate factor by which the reading should be multiplied to get the equivalent of Halliburton counts by second. Other conversion factors can be derived from these.

‡The deflection from zero in inches is divided by the "sensitivity" in inches to get standard units. The sensitivity is obtained by recording the deflection produced by a certain standard gamma-ray source when placed in a predefined position relative to the detector. It is recorded on the log.

§The "sensitivity" is given by a statement on the log heading that a certain number of inches = 100 standard units. For instance, if 3.9 in. = 100 standard units, the deflection from zero in inches multiplied by 100 and divided by 3.9 gives the deflection in standard units.

substitute for the S.P. as can readily be appreciated when it is remembered that the quantities being measured are entirely different in character. In particular, the gamma-ray log cannot give a measure of water salinity while the S.P. can; this is one of the parameters needed for the interpretation of electric logs.

There is no well-developed quantitative use of the gamma-ray log. There have been attempts to use it as a means of estimating the shale content of sands in order to correct the neutron log and thereby to obtain better porosity determinations or in order to correct for the effect of shale on electric logs. Such uses of the gamma-ray log have not proved to be of general applicability because they depend on the often unfulfilled condition that the gamma-ray activity, hydrogen content and electrical properties of the clay in the sand are the same as those of the shale above or below the sand.

In order to make it of more value for correlation and, possibly, for future quantitative applications, accurate calibration of the gamma-ray log should be insisted upon today and made an obligation of the service companies. In some areas certain service companies do not even measure the zero for the gamma-ray log. This, particularly, is inexcusable; uncalibrated logs should not be run if there is an alternative.

The types of detectors used in gamma-ray logging by the various service companies include geiger counters, ionization chambers, and scintillation counters. The scintillation counters have effective lengths of the order of 2 or 3 in. while, in order to attain a comparable sensitivity, geiger counters and ionization chambers must be about 30 in. long. The scintillation counters therefore have better depth resolution and can distinguish beds thinner than 1 ft. compared with a minimum of 3 ft. for a 30-in. detector. We consider geiger counters and ionization chambers for gamma-ray logging to be obsolescent, except for special problems.

The units used for reporting gamma-ray intensity are listed in Table 1. The unit used by McCullough and Perforating Guns Atlas is a conventional one which has been employed for many years for measuring the ionizing ability of gamma-ray and X-rays. The unit used by Schlumberger expresses the amount of radium in 1 ton of rock that would give the same reading as that observed. The units employed by Halliburton and Lane-Wells are calibrated in terms of an arbitrary standard gamma-ray source. Table 1 lists approximate factors for converting readings on one company's gamma-ray log to the equivalent of another company's.

The bore-hole fluid is sometimes radioactive enough to affect the gamma-ray log. Ordinarily this is of small consequence but it should be remembered if quantitative comparisons of logs are being made.

2. The Neutron Log

Quantitative use is made of neutron logs for determining porosity in clean or relatively clean formations. The measurement is affected by bore-hole diameter, casing, cement, the position of the logging sonde in the bore hole, the type of formation, and by the presence of gas. To a minor extent it is affected by salt in the mud and to a smaller extent, by salt in the formation water.

Table 1 lists the units used by the various service companies for reporting neutron response. In contrast to the gamma-ray units the relative values cannot be given by a single conversion factor. Quantitative information on the comparison of the neutron units was not available at the time of writing. Eventually it is hoped that each service company will determine and distribute sets of curves for the neutron log showing its response to bore-hole diameter, bore-hole fluid characteristics, porosity, casing, cement, and sonde position. (No company at the present time has released such a set of curves but it is apparently the intention of one company to publish a set; a paper on this subject is scheduled for presentation at the 1955 fall meeting of the petroleum branch of A.I.M.E.)

In principle, such curves allow correction for all of the factors affecting the neutron log except one, viz., sonde position in the hole. The sonde position is not known so that even if curves were available for correcting for it an adequate correction could not be made. It is known that the matter is of considerable importance but a solution to the problem has not been obtained. An obvious measure is to use a bow spring to hold the sonde against the bore-hole wall or a number of springs to center it in the hole. No service company does this in open hole, but it is one company's practice to use a spring in cased holes. If the casing is centered the sonde position is then defined. A related problem is the effect of mud cake which even with a bow spring would prevent the sonde from making contact with the wall of the hole. We are not now in a position to gage the seriousness of these matters and will not be until sufficient experience has been gained with the use of correction curves supplied by service companies.

Porosity data . . . If porosity values from cores are available for a particular set of bore-hole conditions and if the porosity varies enough over the cored interval to establish a trend, the porosity can be plotted against neutron deflection on semilogarithmic paper to obtain a neutron - porosity calibration curve. The curve is essentially a straight line if porosity is plotted on the logarithmic scale. Considerable scatter is to be expected in these plots since, apart from other reasons which are discussed below, the sample seen by the neutron device is many times larger than the core sample. The scatter can be reduced by properly aligning the depth scales of the log and core data. This is done visually by comparing a plot of the core data with the log.

The scatter can be reduced further by averaging the core data to obtain

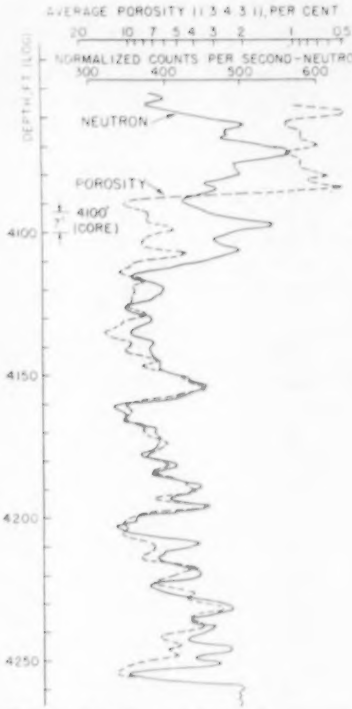


FIG. 1—Porosity correlation for a neutron log in an oil and gas-bearing dolomite (6¼-in. open hole).

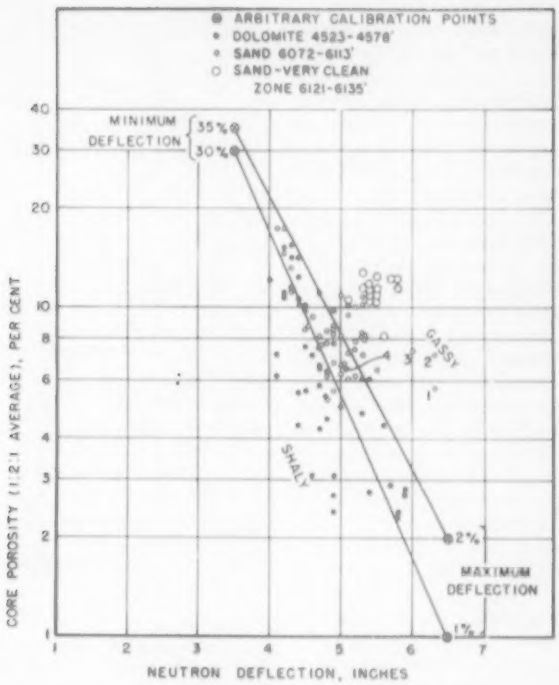


FIG. 2—An approximate method for calibrating neutron logs. Experimental points from core porosities and neutron log in 8¾-in. open hole.

a better sample. The best average to use for most logs is the 1:2:1 weighted average in which three adjacent porosity values at 1-ft. intervals are averaged, the center one being given twice the weight of the outer ones. These porosity correlation diagrams constitute a great part of the published literature on neutron logging and will not be treated at length here.

A "synthetic" neutron log obtained by plotting the 1:3:4:3:1 core-porosity average on a logarithmic scale against depth is compared in Fig. 1 with a real neutron log in the well from which the cores were taken. The interval shown is a gas and oil-bearing dolomite overlain by a low-porosity, slightly shaly zone. The porosity average used, heavier than the 1:2:1 usually employed, fits the log very well because it was run at the rather high speed of 50 ft. per minute and a time constant of 2 seconds; and it consequently had poorer depth resolution than usual.

The gas zone, 4,090-4,110 ft., shows up as a pronounced separation of the porosity and neutron curves. As expected, this zone looks as if it has a lower porosity than it actually has owing to the low hydrogen content of the gas. The interval 4,110-50 ft. may be oil and gas while in the oil interval below 4,150 ft. the porosity correlation is quite good. Incidentally, the nonporous zone above 4,090 ft. exhibits a neutron deflection comparable to that in the gas zone. Owing to the slight shaliness, it is cut back from the deflection corresponding to the porosity. A true shale has an even lower neutron deflection.

An Approximate Method for Determining Porosity from Neutron Logs

In the absence of neutron calibration curves or of core data, the following procedure may be used to obtain an approximate porosity calibration for a neutron log. The smallest deflections are found in shales to which an equivalent porosity of about 30 or 35 per cent can be assigned, particularly in the upper part of the hole, say above 4,000 ft. The largest deflections correspond to small porosities. These can be assigned a porosity of 1 or 2 per cent particularly if it is known that they correspond to anhydrite or dense limestone formations.

Two points are plotted on semilogarithmic graph paper, one at a porosity of 30 or 35 per cent and the minimum deflection and the other at a porosity of 1 or 2 per cent and the maximum deflection. The line connecting these points is a rough porosity calibration. With experience this method can be of considerable value. Its greatest uncertainty lies in the low porosity assignment. Its advantage lies in its simplicity and the fact that it automatically takes into account most of the bore-hole conditions affecting the log. Care should be taken that bore-hole conditions are the same at all points selected for use.

Fig. 2 illustrates this approximate calibration procedure as applied to an actual log and it indicates some of the other features pertinent to the calibration of neutron logs for porosity. The minimum deflection on the log was 3.5 in. and the maximum 6.5 in. The arbitrary calibration points at minimum deflection, 30 and 35 per cent equivalent porosity, and at maximum deflection, 1 and 2 per cent equivalent porosity, are plotted and lines connecting the lower two points and the upper two are drawn. The region between these two lines represents the most probable values of porosity corresponding to the various values of neutron deflection.

In this well two zones were cored. One was in a dolomite and the other in a sand. The dolomite is indicated by the solid circles in Fig. 2 and the sand by the open circles, the large open circles representing the cleanest part of the sand. The experimental points were added to the diagram after the lines were drawn as a check on the procedure. Observe that the points scatter about the lines but substantiate them fairly well.

The rather large amount of scatter is typical of that observed when the porosity changes rapidly as it did in this well and results largely from the fact that the core samples are unrepresenta-

tive under those conditions, and because the simple device of a 1:2:1 porosity average does not adequately represent the behavior of neutrons in an inhomogeneous medium. Other factors are the varying degrees of shaliness in both the dolomite and the sand and the possibility of gas at the top of the sand.

The samples marked "shale" or "shaly" by the core analyst were not plotted. Nevertheless, the points deviating from the calibration lines to the left probably represent shaly zones as indicated. Frequently the gamma-ray log gives a clue to shaliness and warns the log interpreter when the neutron log cannot be trusted for porosity. In this case it accurately picked out the zones indicated in the core analysis as shaly, showing them as gamma-ray highs, but the points in Fig. 2 near the word "shaly" were not indicated by highs on the gamma-ray log.

An additional item of interest is the relative grouping of the dolomite and sand points in Fig. 2. This is one of the very few instances, indeed the only one to our knowledge, in which carbonate and sand zones have been cored and logged in one well. There is a distinct tendency for the sand points to lie at higher neutron deflections for a given porosity. Only a part of this tendency can be explained by gas. The points marked 1, 2, 3 are at the very top of the sand and correspond to a neutron high. This could be and probably is a thin gas zone. Point 4, immediately below Point 3 in depth, and lower points conform to the general trend of the points in the upper part of the sand.

The rather great divergence of the points in the lower part of the sand, a very clean zone indicated by the large open circles, is evident. This is a very interesting fact; it may represent the much sought for "chemical effect" on the neutron log, that is, the effect resulting from a change in the chemical nature of the solid rock material from calcium-magnesium carbonate in the dolomite to silica in the sand. The departure of these points is too great to explain on the basis of the hydrogen content of the oil (the sand is a good oil producer while the dolomite may not be). The hydrogen content would have to be less than half of the normal value to explain the discrepancy. This is quite improbable because the oil was quite normal.

It is more probable that the difference is a chemical effect. The better conformance of the upper sand to the dolomite trend can be explained by the greater shaliness of the sand in that interval, but it is not so shaly that it does not give a fair porosity correlation. A sand as clean as the lower interval in this well (6,121-35 ft.) is extremely rare and this fact may account at once for the pronounced departure in this zone due to its lack of shaliness and to the infrequency of such a departure in neutron-porosity correlations.

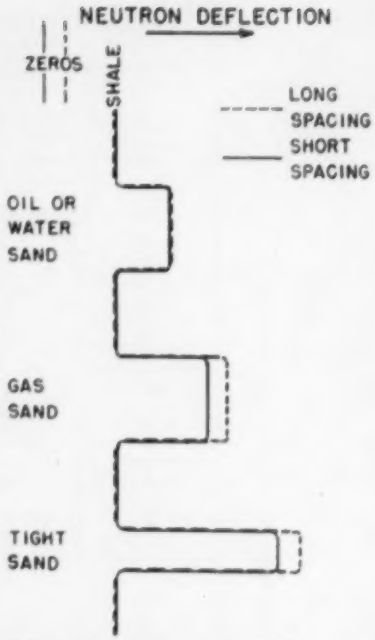


FIG. 3—Schematic representation of the double-spaced neutron method for gas.

Location of Gas with the Neutron Log

In principle, gas can be located by the neutron log since it usually contains less hydrogen per unit volume than oil or water, although this depends on its composition and the pressure and temperature conditions in the reservoir. However, a wet gas, or a dry gas under sufficient pressure, can easily have as much hydrogen per unit volume as water. As an arbitrary figure one would not expect much contrast in the hydrogen content of gas and oil or water at depths greater than 5,000 or 6,000 ft. Invasion of the formation by well fluid filtrate is another factor tending to mask the gas.

Even in those instances where the neutron log responds to gas, it is necessary to know something about the porosity variation in order to distinguish the occurrence of gas from a decrease in porosity. Sometimes this distinction can be made on the basis of the lithology from the sample log and sometimes by a study of the electrical logs. Electrical logs cannot distinguish gas from oil unless the contact between gas and oil coincides with some other change such as an alteration in the cementation in the gas zone.

The double-spaced neutron log has been a successful technique for locating gas in Venezuela (E. B. Walker, unpublished work) but it has not been given an adequate test in this country. The method employs two neutron logging tools with different spacings between the source and the detector or two detectors in the same tool at different spacings. The spacings usually differ by 6 to 10 in. Care must be taken to run the long-spaced log slowly and with a large time constant so that its statistical variation is not excessive, for the counting rate is much lower than that of the regular-spaced log. The recording circuits are so adjusted that the deflections of the short and long-spaced logs are the same in shale and in a known oil or water sand even though the neutron zeros do not coincide.

In a gas sand of normal porosity the long-spaced log will show a larger deflection than the short-spaced log under these conditions. A similar departure of the curves will occur in tight zones even if they contain no gas, and this condition must be watched for in the interpretation. Fig. 3 illustrates schematically the deflections obtained in a water sand (or oil sand) of normal porosity (say 20 per cent), a gas sand of normal porosity and a tight sand.

The double-spaced technique depends on a limited amount of invasion for its success because it capitalizes on the greater penetrating power of the long spacing. In the complete absence of invasion even a good gas sand shows little or no separation between the curves. This happens occasionally but, in such instances, the gas is usually apparent due to the large deflection. Fig. 4, from a report of August 1954 by E. B. Walker, of Mene Grande Oil Co., Venezuela, is an actual example of gas location using the double-spaced neutron log. The nominal values of the spacings were 2.75 and 11.25 in. (the actual spacings are greater than these figures but the difference is correct, viz., 8.5 in. in this case).

The logs were run in 7-in. casing with a logging speed of 25 ft. per minute at a time constant of 5 seconds. Under these conditions the statistical variation of the long-spaced log was too great; hence it was run four times. The dashed curve is the average of the four runs and still has a rather large statistical variation. Nevertheless, the separation of the curves in the gas zone is clearly evident. The multiple running of the long-spaced log was necessitated by the inflexibility of the logging equipment. If the long-spaced curve could have been run at a speed of 6 ft. per minute and a time constant of 20 seconds, the same result would have been obtained with less effort. Improvements have been made in the equipment by several of service companies in order to reduce this difficulty.

Undoubtedly, the double-spaced neu-

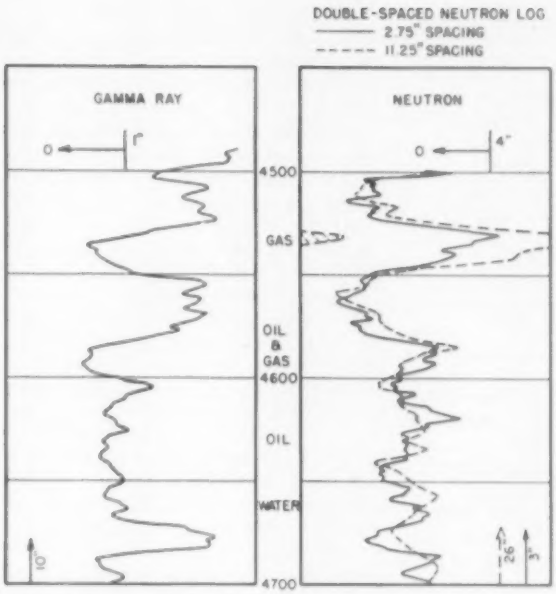


FIG. 4—Example of the double-spaced neutron method for gas.

tron log will be more successful for locating gas in this country when used properly.

A General Method of Electric-Log Interpretation

The decade since the war has been characterized by a greatly expanded understanding of the problems involved in the quantitative interpretation of electric logs. This understanding has been based in large part on the laboratory study of idealized systems. We now appreciate most of the factors which affect log interpretation. In turn we know what measurements must be made if a log is to be quantitatively evaluated. Hand in hand with improved theoretical knowledge has gone research directed towards improving old equipment and designing entirely new logging systems. The so-called conventional log or regular E.S., i.e., an S.P. curve, two normal curves and one lateral curve, is now largely outmoded. Today, ideally at least, we select micro and macro-surveys to suit the lithologic and borehole conditions likely to be encountered in the area to be drilled.

All research indicates that there is one method of log interpretation which is generally applicable. This method consists in plotting the logarithm of the ratio of two resistivities against the S.P. deflection. The ratio plotted is that between the resistivity of the zone adjacent to the bore hole and flushed by mud filtrate and the resistivity of the virgin formation. If the formation is water-bearing it is found that the relationship between the S.P. and the resistivity ratio takes the form:

$$V - E_s = K \log (R_{xo}/R_t) \quad (1)$$

In Equation 1, V is the S.P. read from the log, E_s is a streaming or complicating electrochemical potential found in a manner discussed below, K is a constant which, although often known, can also be found from log data, R_{xo} is the resistivity of the zone invaded by mud filtrate, and R_t is the resistivity of the virgin (uninvaded) formation.

Equation 1 can be simplified if, as is frequently the case, E_s is zero and K is known as a simple function of temperature alone. The parameter R_{xo} can be found, if necessary, from the relationship $R_{xo} = F R_{mf}$. Here F is formation factor and R_{mf} mud filtrate resistivity. Since F is easily calculated from a knowledge of porosity and porosity may be estimated in turn from the neutron log, a gamma-gamma density log or even an acoustic interval-velocity log, many possibilities exist for supplementing data of purely electric-logging origin.

These possibilities are important and must never be overlooked. In general, however, it will be found more convenient and, in the case of interpreting dirty sands, essential to determine R_{xo} directly by a suitable electric-logging technique.

The graphical use of Equation 1 in interpretation is, in essence, a planned method of locating anomalies in the ratio R_{xo}/R_t for any value of S.P. These anomalies can be shown to be the result of oil and gas accumulations increasing the magnitude of R_t relative to that of R_{xo}. The method is applicable to both clean and clay-containing (so-called dirty) sands. For dirty sands, however, the detection of anomalies becomes very difficult unless the mud selected for drilling is of the correct resistivity.

Thus our problem is, in its essentials, the following: How can we best determine S.P., R_{xo} and R_t under varying lithological conditions?

Determination of S.P.

If a formation of interest is clean, i.e., contains no clay, the problem of obtaining an S.P. suitable for quantitative calculations is simple. All that is required is that the equivalent salt content of the interstitial waters in formations of interest be at least twice that of the mud. Generally speaking, however, because of considerations related to the determination of R_t (discussed below) the salinity of interstitial waters should exceed that of the mud by a ratio of about 10 to 1. However, if the interstitial water is particularly saline a rather higher ratio may be used with advantage in order to avoid muds of singularly high salt content. The larger the ratio used, the larger is the S.P. observed.

In certain exceptional cases where the mud is normally extremely saline (as a consequence, for example, of drilling through salt beds), it may be desirable deliberately to sacrifice all S.P. development by adding further salt to the mud so as to insure a ratio of unity, or even a fractional ratio, between the salt content of mud and interstitial brines. Such mud conditions are ideal for the determination of R_t with a laterolog or Guard log (see below) but sometimes lead to difficulties in distinguishing sands from shales. Normally, however, nuclear logs adequately resolve the latter difficulty. It is imperative to recollect that a very **salty mud must never be used unless formations of interest are known to be clean.**

A reliable maxim is the higher the clay content the higher should be the ratio. The reason for this rule is easily visualized. Admixing clay with a sand tends to make the electrical properties of the sand similar to those of a shale; thus it tends to reduce the S.P. of the sand toward the shale base line. If a high-salinity ratio between the water in the dirty sand and the mud is used, the S.P. may be reduced but it remains, nevertheless, reasonably clear-cut.

On the other hand, if the salinity contrast is small the S.P. even in a clean sand is not large; in a dirty sand the S.P. may become virtually zero. It has been found that if the extent to which the S.P. of a dirty sand is reduced can be assessed (which means sufficient remanent S.P. to be accurately measurable), a great deal can be deduced concerning the productive possibility of the sand. On the contrary, if the S.P. is very small owing to the use of an inappropriate mud, the sensitivity of methods based on the use of the S.P. is greatly decreased.

If the left-hand side of Equation 1 goes to zero, we know that for a water sand R_{xo} will equal R_t. This relationship applies to both clean and dirty sands. If, however, the sands contain oil R_t will be larger than R_{xo}. For dirty

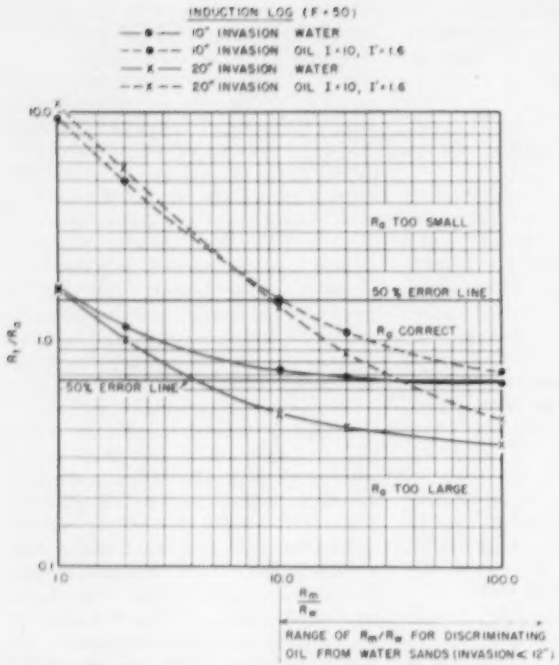


FIG. 5—Effect of ratio of mud resistivity to formation water resistivity and depth of filtrate invasion on the accuracy of a 6FF 27-in. induction log (I = resistivity index of formation, I' = resistivity index of invaded zone).

oil sands the difference between R_t and R_{xo} is not large and for good interpretation it is imperative that we take this fact into account. If we have no S.P. we cannot use this curve to distinguish dirty sands from clean sands. We are not, therefore, on the alert to spot the possibility of an oil-saturated dirty sand. Mathematically speaking, we are in a region of indeterminacy. To get out of it we must have a high ratio of interstitial water to mud salinity.

It is considerations such as these which make it essential that the production and geological departments work as a team, each aware of the other's problem, if the best logging results are to be obtained. This is now well recognized. Thus it is agreed that the use of salt-water muds in offshore wells at the present time is most undesirable. Yet the sheer technical and economic problems associated with offshore drilling—making muds sufficiently fresh for good log interpretation—have still to be solved. That the problem is indeed recognized is the first step to its practical solution.

Determination of Invaded Zone

Until the advent of the first of the contact logs, the MicroLog, those concerned with the theory of log interpretation were in a painful predicament. On the one hand, they knew that if R_{xo} could be measured the problem of log interpretation was, in theory at least, solved. On the other hand, they knew of no method whereby R_{xo} could be derived, except in rare cases, from conventional logs. The MicroLog, more generally contact logs, entirely altered the picture. For the first time an instrument was available which was capable not only of delineating permeable formations but also of giving information from which R_{xo} could be derived. Experience has shown that a contact log by itself cannot always yield values of R_{xo} with acceptable precision. If porosities are less than 15 per cent a contact log is, for this purpose, inaccurate. However, what is essentially a focused contact log, the Microlaterolog, has been added to the interpreter's repertoire. If porosities are less than 15 per cent the R_{xo} of permeable intervals located by a contact log are read from the Microlaterolog.

The fact that either a contact log or both a contact log and Microlaterolog **must** be run if a log interpretation is to be attempted is perhaps insufficiently realized. These devices are absolutely essential, the breakover point between the use of one or both being a porosity of 15 per cent in formations of interest. In wildcat wells both should be run as a matter of course. In the words of a very well-known log interpreter, M. P. Tixier, "No MicroLog—no interpretation!"

It may be argued that if a microdevice only enables $R_{xo} = F R_{mf}$ to be determined and if, as noted above, F may be obtained from a measurement of porosity, then any log which measures porosity may be equally satisfactory. Were all sands clean this argument would have merit in spite of the fact that it implies that we have a precise knowledge of the relationship between formation factor, F, and porosity; this is not the case. However, any lack of precision here is generally of small significance in the over-all interpretation picture.

What is of major significance is the fact that if sands are dirty, R_{xo} itself must be directly measured since, for such sands, R_{xo} is no longer equal to $F R_{mf}$. The presence of clay in a permeable formation serves to destroy the normally simple ratio (F) between the resistivity of a permeable sand saturated with a conducting solution and the resistivity of the solution. Fortunately, however, to a satisfactorily close approximation it does not destroy the validity of Equation 1 if R_{xo} in that equation is actually measured for the dirty sand in situ.

Microdevices are not unduly sensitive to the salt content, i.e., the resistivity, of muds used to drill a hole. Thus, muds satisfactory for S.P. or resistivity logging do not generally complicate the interpretation of logs given by microdevices. It is desirable, however, to use muds which do not build up thick filter cakes. In general, this means that natural muds should be avoided and more expensive types favored. As usual one does not get something for nothing; better log interpretation generally means a higher mud bill. But it means also, let us add, substantially lower testing costs.

Determination of True Resistivity, R_t

Conventional logs are adequate for the measurement of R_t only when formations are rather thick and not deeply invaded by filtrate, i.e., their thickness should exceed about 50 ft. It is true that there are methods of using the 64-in. normal curves which permit the estimation of R_t in beds as thin as 10 ft. These methods are, however, far from satisfactory inasmuch as uncertainties concerning the extent of filtrate invasion may lead to serious error.

The most elegant method of measuring R_t is by the use of an induction log. Unfortunately, although the principles on which an induction log is founded were well known, the technical difficulties associated with producing a practical instrument with a stable zero proved insuperable until quite recently. During the last few years there has been offered commercially a focused induction log which, in its best form, was known as the 5FF 27-in. Type G. This device, as its designation implied, had a spacing of 27 in. It was in almost all circumstances impervious to the effects of bed thicknesses beyond a lower limit of about 6 ft.

While the induction log proved an admirable device for use in thin beds, it was subject to two drawbacks. The first was its sensitivity to the ratio, resistivity of mud/resistivity of interstitial brine, and the extent of filtrate invasion. The second was its inability to give reliable resistivities in zones having resistivities in excess of about 60 ohmmeters.

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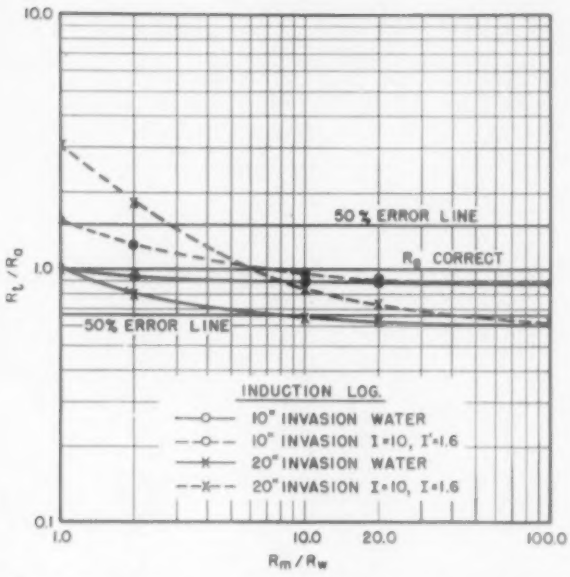

FIG. 6—Effect of ratio of mud resistivity to formation water resistivity and depth of filtrate invasion on the accuracy of a 5FF 40-in. induction log (I = resistivity index of formation, I' = resistivity index of invaded zone).

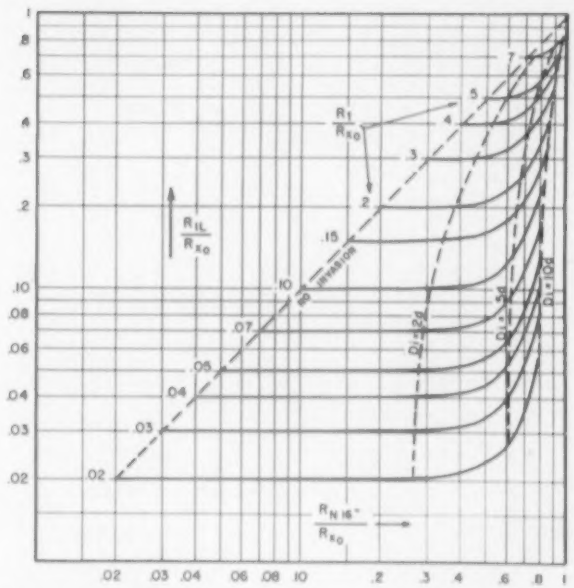

FIG. 7—Method of correcting induction log for effects of filtrate invasion. (Courtesy Schlumberger Well Surveying Corp.)

6FF 27-in.* log to variations in the ratio R_m/R_w (resistivity of mud/resistivity of interstitial brine) is shown for a typical case in Fig. 5. On Fig. 5 the ratio R_t/R_a represents the ratio of the true resistivity of the formation to its apparent resistivity, i.e., that read directly from the log. Ideally this ratio should always be unity since this would mean that the log was always recording true resistivity directly.

In fact Fig. 5 shows that two requirements must be satisfied before R_a is in reasonable agreement with R_t. First, it is essential that R_m/R_w exceed 10; secondly, the radial depth of invasion by mud filtrate must be less than 10 in.

We have already dwelt on the desirability of using a high R_m/R_w ratio, particularly when sands are dirty. If the induction log is used this requirement is made mandatory.

The critical effect of invasion depth on the accuracy of the 6FF 27-in. induction log has recently led to the introduction of the 5FF 40-in. device. The 5FF 40-in., as its designation implies, has a spacing of 40 in. This increase makes the new device slightly more inaccurate when logging very thin beds but this minor disadvantage is more than compensated by a much greater imperviousness to the adverse effects of invasion by mud filtrate. Fig. 6 shows this clearly. The 40-in. device is, in fact, able to give the same quality data as recorded by the 27-in. device even though the volume of filtrate entering the formation increases by about 240 per cent. Note that Fig. 6 shows that even with a 40-in. device **the ratio R_m/R_w must exceed 10.** The new 40-in. device is also able to record resistivities up to 200 ohm-meters although values above about 120 ohm-meters are probably not trustworthy.

While the 5FF 40-in. device is less sensitive to invasion by mud filtrate than the 6FF 27-in., Fig. 6 shows all too clearly that it is by no means completely insensitive. It happens, however, that if R_{xo} can be found the apparent resistivities recorded by an induction log can be corrected to true values by the aid of the apparent resistivities recorded on a 16-in. normal log. The method is shown graphically on Fig. 7. In order to utilize curves of the type shown on Fig. 7, it is now possible to run simultaneously an S.P. log, 16-in. normal log and 5FF 40-in. induction log thereby giving in one pass a conventional log suitable for correlating with earlier conventional surveys and means for correcting the R_a values read from the induction log to R_t. It need scarcely be added that necessary microdevices must also be run separately.

We have referred above to the use, in exceptional cases, of highly saline muds. If these muds are used, focused logs such as the Schlumberger laterolog or Halliburton Guard log must be run if R_t is to be found. Fig. 8 shows graphically some of the advantages and disadvantages which are typical of the laterolog and Guard log. It is quite evident that if the error in R_a, i.e., the ratio R_t/R_a, is to be small the ratio R_m/R_w must be less than 2.0 and, preferably, less than 1.0. From this it follows that if as the result of drilling salt beds or other operating reason a highly salty mud is incurred, one is better off if one then goes the whole hog and deliberately makes a saturated salt-water mud. In other words, if one cannot achieve a value of R_m/R_w greater than 10 suitable for induction logging, one should weigh very carefully the possible benefits of making $R_m/R_w < 1$ in order to use a laterolog or Guard log.

Once again, however, we point out that low ratios of R_m/R_w are feasible only if dirty sands are of no interest. In practice the salt mud technique is limited to carbonate rocks since these are normally clean. A well-known example of the successful utilization of the salt mud technique is in the Kansas City-Lansing formations in Kansas. Here a laterolog or Guard log is used to obtain R_t and a neutron log to estimate porosity and, hence, formation factor. For this technique water salinities must be known from samples or at least known to be constant.

The Detection of Anomalies

Equation 1 contains two unknowns; these are the quantities E_s and K. E_s can be zero or as much as 40 mv. depending upon conditions. K, on the other hand, is normally about 75 to 85 (depending on temperature) but if interstitial waters are relatively rich in such ions as calcium and magnesium, K may be nearly twice this figure. Fortunately, in a particular well there is a marked tendency for E_s and K to be rather constant. Thus, if we plot log R_{xo}/R_t against S.P. for all possible permeable sands in the well, we

*An earlier version of the 5FF 27-in. device with essentially similar characteristics.

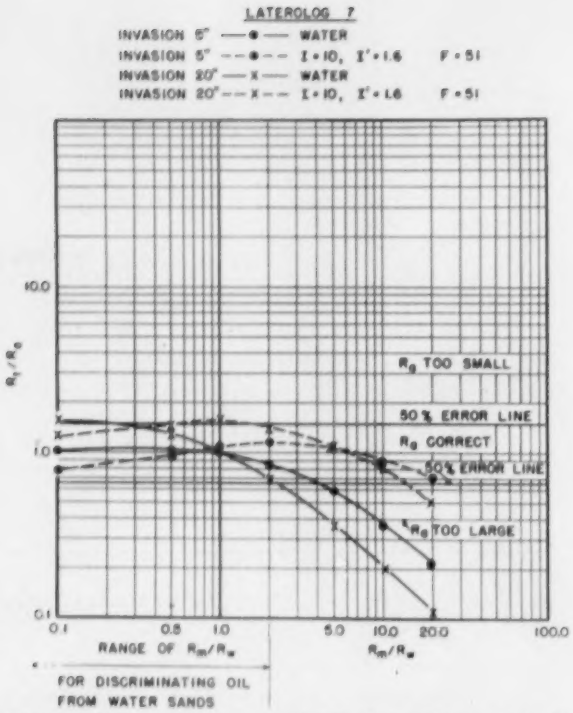

FIG. 8—Effect of ratio of mud resistivity to formation water resistivity and depth of filtrate invasion on the accuracy of a laterolog 7.

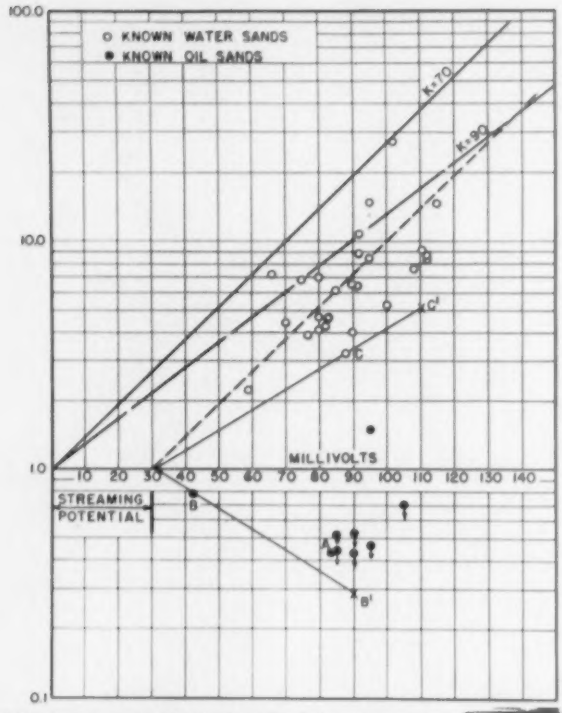

FIG. 9—General method of electric log interpretation (data from Venezuela). Plotting log R_{xo}/R_t against S.P.

frequently end up with a result similar to that shown in Fig. 9. The data of Fig. 9, in fact, represent a typical Venezuelan interpretation, a contact log being used to find values of R_{xo} and an induction log values of R_t. The ratio R_m/R_w was in excess of 20.

The scatter of the open circles on Fig. 9 is due in part to variations in E_s and K from bed to bed but mainly, in all probability, to errors made in finding R_{xo}, R_t and S.P. The error in the last quantity arises when it is necessary to estimate the average S.P. of a dirty sand or the full S.P. in a bed so thin the S.P. is pointed and thus, probably, not fully developed.

The solid circles refer to sands which are definitely known to be productive. The downward pointing arrows indicate the fact that the determination of a true R_t was impossible since the resistivities exceeded the upper limit of the old-type induction log used (about 60 ohm-meters). Thus the points marked with arrows should actually be displaced downward from their plotted positions.

On Fig. 9 the line marked K = 70 is a theoretical line for normal waters (i.e., principally NaCl in character) and E_s = 0. The line marked K = 90 would be a line corresponding to somewhat abnormal waters, E_s again being zero. A consideration of the open circle data seems to show that if Equation 1 is to be applied the best solution for E_s and K appears to be E_s = 30 mv. and K = 70. This relationship is shown by the broken line. Potentially productive sands are then indicated by points which, at any value of S.P., fall **below** the dashed line, the extent of the displacement being directly proportional to the hydrocarbon content in the event the sands are clean. For example, the resistivity index of the point marked A is approximately 5.6/0.44 or 12.7.* This follows because R_{xo}/R_t for point A is about 0.44 while the value of R_{xo}/R_t on the dashed line at the same S.P. (82 mv.) is about 5.6.

Point B is a very dirty sand containing oil. It will be observed that its displacement from the dashed line is very small and no greater, for example, than the open circle C corresponding to a water sand. Whether points B and C correspond to oil or water sands may be estimated by following procedure:

Draw from the intersection of the dashed line with the line R_{xo}/R_t = 1.0 radial lines through points B and C as shown on Fig. 9 until these lines intersect the maximum S.P. corresponding to beds in the immediate vicinity of the beds to which the points B and C refer. If this is done the points B′ and C′ are obtained. The corrected resistivity index of the bed corresponding to point B is now about 7/0.3 or 23.3 and that corresponding to point C is about 14/5 or 2.8. Thus the former bed is definitely productive while the latter contains, at best, only a residual hydrocarbon content. This method of correction, at least when applied to formations containing interstitial clay, is only approximate.

The technique shown graphically in Fig. 9 is thus flexible inasmuch as it permits variations in K and E_s to be determined, is applicable to both clean and dirty sands and, in the light of our present knowledge, is the one we recommend for field use. Its success in any particular case rests squarely on the correct choice of mud resistivity and logging tools. Unless R_{xo}, R_t and S.P. can be determined with precision the technique must fall. Thus again we draw attention to the necessity of a planned approach to the logging program. This means in practice that the regional logging specialist, the exploration geologists, and the production engineers must recognize their logging, their lithological, and their drilling problems before a well is spudded and plan their mud and logging program accordingly.

*Actually the resistivity index is greater by a factor of about 2.0 since we are ignoring the increase in R_{xo} resulting from residual unflushed oil.

Acknowledgments

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Bankers Like to Do Business With Oil Men

Here's a rundown of various types of petroleum financing

by Lyon F. Terry

THE petroleum industry suffered a double blow during the depression of the early thirties. In addition to the world-wide economic collapse affecting all industry, the oil companies faced the impact of the rapid development of East Texas oil field.

This field was discovered in October 1930 and within 9 months threw on the market 750,000 bbl. per day of cheaply developed production at a time when the country's daily consumption was only 2,500,000 bbl. It had to be shut in by Texas state troops and then prorated, after a fashion, before legal machinery had been perfected on such control.

At the same time, overproduction in Oklahoma City field drew out the state militia there. The posted price of representative 36° A.P.I. Mid-Continent grade crude oil in 9 months broke from $1.29 to 18 cents per barrel, whereas East Texas oil sold at any price obtainable—as low as 5 and 10 cents per barrel. The rate of drilling new wells dropped to about one-third of the previous normal, and the producing companies drastically reduced their exploration personnel. And for several years a chaotic supply-demand-price situation prevailed.

Financing independents . . . Under such conditions development and expansion by the independents had to be financed, if possible, by equity money; there were few bank loans possible, and those had to be of short maturity. Even prior to the depression, the violent fluctuations in crude-oil prices did not inspire confidence in producing property.

For example, after World War I the price of 36° A.P.I. Mid-Continent crude oil rose to $3.50 per barrel, holding through 1920. It fell in 1921 to $1, and in the 1921-1930 decade there were 23 increases and 27 decreases in posted price. Those up-and-down changes were wide—the price ranging from $1 to $2.29.

During periods of overproduction and low prices, drilling was retarded and fewer new fields were discovered. As production declined, oil was withdrawn from storage, refiners competed for crude oil, and the price would rise. This induced expansion in drilling programs and new fields would be brought in, thus completing the cycle.

Wells were permitted to produce at their maximum productive capacity, and the gushers in new fields often quickly oversupplied the market. There was no official proration or regulation (until 1927), and the oil-producing industry was a feast or a famine business. The basis for credit to oil producers is the value of property and the probable future profits from production. How could bankers rely upon any appraisal of reserves when the price of oil was known to fluctuate so widely?

Both producers and consumers badly needed a control which would stabilize supply and prices. The mechanism adopted was proration—the allocation of production by properties and fields and restricted to market demand.

The State of Oklahoma inaugurated proration in Seminole field in 1927. East Texas and Oklahoma City fields were placed under state control in 1931. By 1935 the State of Texas passed its revised conservation law, and many other states shortly followed suit. These laws were based upon the state's power to reduce production for the purpose of preventing waste, inasmuch as production at excessive rates dissipates reservoir energy and lessens the ultimate recovery.

But fortunately the restriction also limited production to "market demand," which has the economic effect of stabilizing prices. Thus the conservation laws have enabled the several state commissions to increase the ultimate recovery of the natural resource and, at the same time, hold production within reasonable limits and thereby prevent the former violent fluctuations in crude-oil prices.

Price fixed . . . After the severe price reduction caused by the depression and the East Texas field, the price of 36° A.P.I. Mid-Continent crude oil was arbitrarily raised to $1 by Secretary Ickes in late 1933 and held at $1 or slightly above until World War II. With the gradual establishment of the proration procedure, price fluctuations have practically ceased.

The last general price cut in Mid-Continent crude oil occurred in August 1939 when some companies reduced prices in Texas by 20 cents per barrel. The Texas Railroad Commission immediately declared this to be in violation of the conservation statute and shut down most of the wells in the state. The former price was restored 16 days later and held through the war.

There have been several raises since the war to the present price of $2.82, but there has been no general price cut in 36° A.P.I. Mid-Continent for 16 years.

Prior to proration and the unitization of oil fields, the oil in any new field belonged, under the "rule of capture," to the operator who produced it, whether it had originally underlaid that producer's lease or had migrated from adjoining properties. Hence there was intense competition among producers to get in early, drill up their acreage first, and produce as fast as possible.

Wells were allowed to produce at their full capacity, and newly discovered properties often produced half of their entire ultimate production during the first year. It was a wasteful process, but it was then the law of the land. Estimates of reserves were based upon the average rate of decline of similar fields by the use of so-called "family decline curves," the best method then known but certainly far from accurate.

Technology improved . . . While controlled conservation was being established, much progress was also accomplished in improving the tools and knowledge of petroleum engineering. In the early thirties the electric log and core analysis came into extensive service, providing a measurement of the porosity, permeability, water contact, and so on, of the sand.

Scientific studies were carried out on the producing mechanism of the flow of liquids through sands, the effect of the expansibility of water, the supercompressibility of gas, retrograde condensation, the material-balance calculation, and the effect and advantage of pressure maintenance and repressuring.

These and other advances in the engineering of production not only led to increased recovery, but provided the basis for much more accurate judgment of the recovery to be expected under different conditions of production, and thereby greatly increased the

Author is vice president, Chase Manhattan Bank, New York. Paper presented at annual meeting, A.P.I., San Francisco, 1955, under the original title, "Petroleum Financing."

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reliability of the reports of petroleum engineers.

It took a long time for bankers to forget the old price gyrations and the overproduction of the early thirties and to learn to appreciate oil and natural-gas reserves and production as security for loans. But, as the authority and effect of the state-commission orders slowly became recognized, the stability of producing property became more and more respected.

The transition did not occur overnight nor by any single stroke of genius. It came through the concerted effort of statesmanship of the industry and the state authorities, and their admirable cooperation in breaking new ground for the conservation of the resource and the stabilization of the business.

At the same time the development of improved engineering techniques resulted in better estimates of recoverable reserves. These efforts have greatly improved the confidence accorded the producing industry by investors and lenders.

Gas position . . . There has been a parallel improvement in the position of natural-gas producing properties. The large natural-gas reserves of the country were found in the search for oil and became available as a secondary product to supply distant markets, but it took years of development in the art of transporting gas through longer and larger pipelines and a changeover from manufactured to natural gas in those distant cities.

Thus the supply was developed much faster than the market, and many years were required for the increasing demand to catch up with the potential supply and induce prices in the field comparable with the competitive value of the resource.

For example, in the mid-thirties the gas reserves of Panhandle-Hugoton field were enormous, but the demand from distant cities represented only a small portion of the potential production of the field. The price was then 4 cents per thousand cubic feet with many small sales at 2 cents.

In the South Texas Gulf Coast the extremely large reserves found very little interstate markets until 1944 (only 11 years ago). In the following decade long-distance gas pipelines were built to almost all areas of the United States. A practice of contracting for the sales of gas to these long pipelines has been established whereby the producer is assured of a minimum take at fixed prices, generally subject to future escalation.

Thus, apart from the current legislative controversy as to regulation of gas prices for sales in interstate commerce by the Federal Power Commission, natural-gas producing property has become highly regarded as security for loans to producers.

Reserves appreciating . . . Since World War II the favorable effect of inflation upon the value of natural resources has been well recognized, with the result that oil and natural-gas reserves are increasingly appreciated as a hedge against further inflation and as security for lending.

For many years our petroleum department has assembled and combined financial data for 30 large oil companies, representing about 60 per cent of the net crude-oil production and 85 per cent of the refinery runs in the United States. Although these data by no means cover the entire industry, some measure of the trend of financing may be observed from the record in Table 1.

As the figures in Table 1 show, there were very few bank loans to the oil companies during the depression until the industry began to recover, and the stabilizing effect of proration and improved engineering became increasingly recognized.

Although 20 years ago loans based on oil properties were limited to a year or 18 months, very gradually, as the oil business attained more stability, it became the practice to extend the term of production loans to 3 years, then 5 years and, in the case of exceedingly long-life properties, to 10 years by banks and longer by insurance companies. Old-time bankers, particularly in the big city banks far removed from the oil centers, had been in the habit of examining the applicants' past income and balance sheets.

In the early days of developing the practice of term loans to oil producers, it was quite an experience to go before the loan committee with a request for a 10-million-dollar loan to be secured by property with a book value of $500,000. But, in judging such loans, the past earnings and book value mean little; the criteria to be considered are the value and the payout of the property offered as security, no matter what it cost.

And, to accomplish this, there has sprung up throughout the country a profession of petroleum-valuation consultants, and some oil banks have organized oil departments staffed with petroleum engineers and technical men.

Types of Petroleum Loans

The largest volume of financing in the petroleum industry is to the large companies of prime credit rating. Such lending warrants the lowest possible interest rates and requires little or no engineering technique.

TABLE 1—LONG-TERM DEBT OF 30 OIL COMPANIES[1]
(Millions of dollars)

Dec. 31	Banks	Insurance companies	Public and others	Total
1933	1	0	870	871
1934	9	26	732	767
1939	48	202	775	1,025
1944	145	153	734	1,032
1949	802	934	868	2,604
1954	554	1,148	1,556	3,258

Where a company plans an extensive expansion program for the construction of refineries, pipelines, or field development which will require capital funds of undetermined amount, it is practice to arrange a credit agreement by which the borrower has a call on money over, say, a 2-year standby period. During this time he may draw down funds as needed, with the commitment by the bank that at the end of the standby period such borrowing can be converted to term loans.

The borrower pays a standby charge at a modest rate on the unused portion of the commitment.

Production loans . . . An important type of financing is to oil and natural-gas producers. Such loans are generally secured by mortgage on the producing properties and the assignment of all or part of the production income, with a stipulated minimum monthly payment.

In determining how much money can safely be loaned on oil and natural-gas producing properties, the first test is the valuation of the property—which we consider to be the fair market value, or what the property would sell for. The loan should not exceed a reasonable proportion of the value, an index referred to as the "loan ratio."

Another yardstick is a forecast of the net cash revenues which the property will produce, by years, for the retirement of the loan. As a general rule, we feel that the estimated total future production of the property should be at least twice the amount needed to repay the loan with interest.

In practice, the valuation of the property is found by discounting the estimated future net-cash production to present worth, so that the valuation and the forecast of future revenue tie together and each provides a check upon the other.

In our bank we practice a process of valuation described in the paper, "Valuation of Oil and Gas-Producing Properties for Loan Purposes."[2]

During the past 2 or 3 years we have found values determined by the methods described in that paper to be closely comparable with prices actually paid in the case of several large sales of property; hence, we feel that this proc-

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ess has been validated by bona fide evidence of fair market value.

Engineering estimates . . . The evaluation of producing property depends primarily upon estimates by petroleum engineers of the oil reserves and the future decline in production. A prudent lender, knowing full well that before the loan is paid off such estimates, at best, may prove to have been too high (or too low), will insist upon an ample factor of safety between the amount loaned and the estimated value of the property.

Also, bank loans must be limited to a reasonable maturity because the commercial banks need to maintain an over-all position of liquidity. Thus, in the usual case, a 5-year bank loan may be considered a satisfactory term although, if the property securing the loan is of exceedingly long life, the term may be extended.

Because the banks must obtain deposits in order to make loans, it is customary in commercial banking for the borrower to maintain appropriate deposit balances with the lending bank. This possible disadvantage from the standpoint of the borrower is more than offset, we believe, by the flexibility available in bank financing, inasmuch as the oil banks are well prepared to quickly adjust, reduce, enlarge, or extend loans secured by oil properties, where circumstances warrant. And oil producers in the development stage frequently need to change their plans and financing requirements.

Oil-Payment Financing

With the greatly increased income-tax rates brought on by World War II, a special method of sale of oil and natural-gas producing properties was developed involving the use of the oil and gas production payment, often termed "oil payment."

An oil payment represents the ownership of a specified portion of the production of a property, until the proceeds therefrom, free and clear of expenses, shall amount to a specified sum plus interest thereon at a stated rate.

There are usually three parties to the transfer of property by the oil-payment method: the purchaser of the property subject to the oil payment, the buyer of the oil payment, and the seller of the property.

1. The purchaser of the property is obligated to operate and develop the property and will obtain possession of the entire production upon the retirement of the oil payment.

In the meantime, the proceeds from that portion of production dedicated to the oil payment is not taxable income to the operator. He pays very little income tax during the term of the oil payment because it is so designed that his net after expenses will be just sufficient to provide for operation and development costs.

The oil-payment method of buying property enables the purchaser to pay in cash only a small part of the total cost, and without incurring liability for the balance of the purchase price, which is provided by the oil payment. This is a distinct advantage over the method of financing the purchase of property by a straight production loan, for which the operator is liable.

2. The buyer of the oil payment, in practice, borrows the entire face value at a slightly lower rate of interest than that stipulated for the oil payment. He pays no income tax on his share of the production income, except on the portion applied to interest, inasmuch as such revenue is returnable tax-free as depletion on cost.

This privilege cannot be availed of in Canada where the tax laws do not allow depletion on cost.

3. The seller, who receives cash payments simultaneously from the purchaser of the property and the buyer of the oil payment, is subject to capital-gains tax of 25 per cent on the excess of the sum of these payments over the cost of the property to him.

An individual in a high tax bracket who owns developed property will often find it advantageous to sell out and realize at least 75 per cent of the property's value at once rather than to continue to operate for many years and net the relatively small portion of future earnings left after heavy personal taxes.

Because the joint purchasers will need to pay no income tax of consequence during the life of the oil payment, they can afford to pay a larger aggregate amount than an outright buyer who would be subject to income taxes from the outset.

In the previously mentioned paper on valuation it was shown that the purchase price of a property can be as much as 20 per cent higher through the use of the oil payment, and any property will support a larger oil-payment loan than a straight production loan, inasmuch as the tax savings increase both the value of the property and the future revenue available for debt service.

Variations . . . There are many variations of the oil-payment procedure. For example, some owners hesitate to relinquish their complete equity in a property, feeling that eventually the price of oil (and especially of gas) may rise or that additional reserves may be found.

In such cases, the owner may sell the property, subject to a first oil payment which is simultaneously sold, and further subject to a second oil payment, subordinate to the first, and retained by the seller.

However, the use of the oil payment is not indicated in certain cases. Because the advantage is in minimizing income tax during the life of the oil payment, it will result in no savings in cases where the purchaser will be drilling extensively, thereby keeping out of income taxes.

Moreover, where the purchaser needs the entire income from the property purchased in order to pay for further development, he cannot afford to dedicate a portion of the production to an oil payment.

A producer may also sell an oil payment while retaining the residual interest in his property. In this case, the consideration received is held to be the sale of future production, taxable not as capital gains but as current income in the year sold.

When an operator, because of drilling expenditures or for other reasons, has deductible losses for a given year in excess of taxable income and is unable to carry forward the excess losses, it is advantageous to sell an oil payment.

In effect, the operator is selling an interest in future income, but for tax purposes the proceeds of sale immediately become ordinary income. In this way the operator is able to minimize his taxes over the long run by making use of all of his deductibles.

However, there have been two lower-court decisions this year which, contrary to established practice, held that the proceeds of sale of such oil payments should be taxed as capital gains. Unquestionably these decisions will be tested in the courts.

When financing the purchase of an oil payment, the lender customarily is secured by a mortgage of the oil payment and by assignment of the income; and both the lender and the oil-payment owner must have assurance that the operator of the property is capable, reliable, and will properly operate and, if necessary, further develop the property until the oil payment is satisfied, regardless of how long that may take.

Gasoline plants . . . Natural-gas processing plants extract natural-gas liquids from the gas processed—often produced by others—and retain a percentage of the liquids produced as a fee. Motor fuels so produced compete with the products of the large petroleum refineries. This involves the hazard and expense of keeping up with the octane race.

Wide fluctuations in the prices of liquefied petroleum gas produced also add to the risks of financing such plants. Loans are secured, seldom exceed 5

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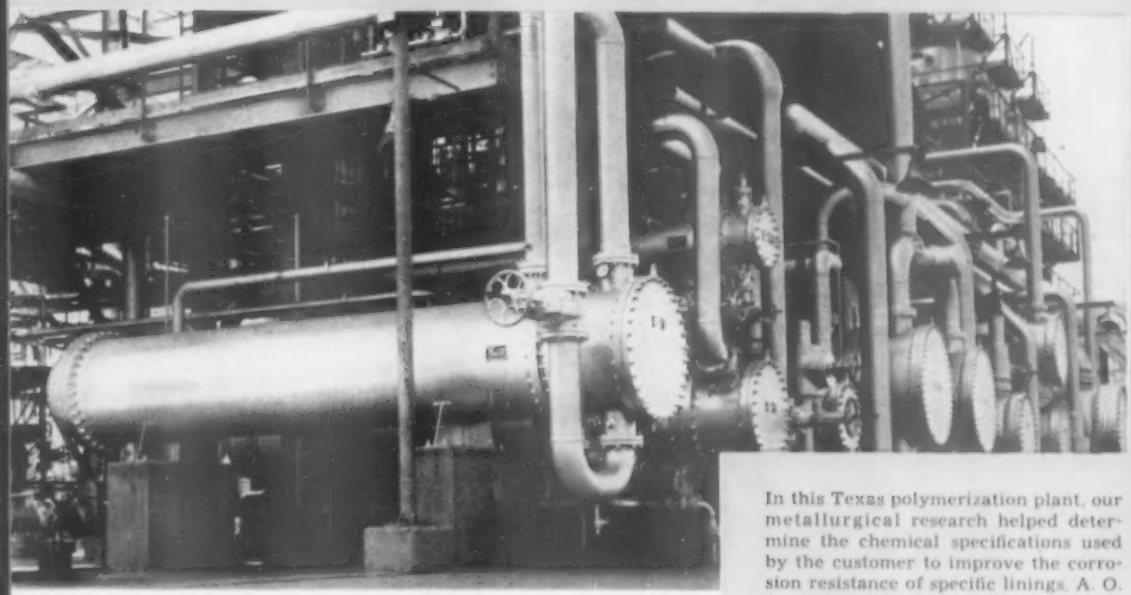

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years, and interest rates are relatively high. Where the loan is a high proportion of plant value, a partial guarantee by the borrower's principal stockholders is sometimes required.

Refineries . . . The smaller independent refineries face keen competition from the majors, characterized by fluctuations in product prices and the necessity for frequent plant improvement to compete with higher quality products.

In addition to mortgage on the plant, loans are often secured partly by crude-oil reserves, inventories, receivables, and the assignment of marketing contracts.

Pipelines . . . Interstate oil and products pipelines are subject to a federal limitation generally restricting dividends to 7 per cent of valuation. Relatively long-term financing, frequently 10 or 15 years, is customary. Commercial banks finance up to 10-year maturities and often share such financing with insurance companies which take the later maturities.

Loans are usually secured by mortgage and/or by throughput agreement, assuring revenues adequate for operating expenses and debt service. Where such agreements are with major companies, interest rates are relatively low.

Tanker loans . . . Tankers are often owned by independent operators who lease the vessels to major companies under bareboat charter, with charter hire sufficient to amortize a loan secured by a preferred ship mortgage in, say, a 10-year period. The insurance carried and the charter provisions must be adequate, thereby warranting interest rates predicated on the credit of the major.

Loans for construction of tankers are also made to or on the credit of a major with borrowings made progressively with construction, and to be converted to longer term loans upon completion of the vessels.

Service stations . . . Where a major oil company prefers to lease service-station properties, perhaps with an option to purchase, the assignment of its unconditional rental payment provides excellent collateral and calls for interest rates accorded such major. Maturities range from 10 to 20 years, and 10-year financing is readily handled by banks.

Future Financing

Since the depression of the early thirties, the consumption of petroleum products in this country has increased very nearly as a straight line at an average rate of 5.8 per cent per year. During the past 10 years domestic consumption rose from 4.86 million barrels per day in 1945 to an estimated 8.35 million in 1955, or 73 per cent.

It is interesting to note that, if the allied resource natural gas be included, the combined consumption on a B.t.u. basis has almost doubled in the past 10 years.

In looking forward to the probable growth for as much as the next 10 years, many factors need be considered. Our domestic demand may increase approximately 50 per cent by 1965.

The known reserves of crude oil in this country are about 13 times 1 year's production. Every barrel of oil produced must be replaced by a barrel of new reserves and this, together with the cost of finding and developing new reserves to support the increase in production, will require enormous new capital expenditures.

For the 35 large oil companies included in the Financial Analysis of the Petroleum Industry for 1954 by Frederick G. Coqueron, of our bank, the cost of finding and developing new reserves in the United States was equivalent to $1.76 per net barrel of crude oil produced in 1954. This unit cost has been increasing (from $1.22 in 1949) and, with rising cost levels and the increasing cost of finding new reserves, it will probably continue to go higher.

At the same time the country's refineries, pipelines, shipping, marketing, and petrochemical facilities will also be improved and expanded. Thus it can reasonably be assumed, granted a steady growth of the whole economy, that the petroleum industry's capital expenditures in the United States of 5.7 billion dollars in 1957 may reach or exceed 9 billion dollars per year by 1965.

Source of capital . . . What part of these large capital outlays will be generated from earnings and what will need come from outside capital markets—the banks, the insurance companies, and the public? A key to this question may be found in the combined figures for 30 large oil companies assembled by our petroleum department for many years.

These data show that those major companies generate a very large portion of their capital requirements out of earnings, with long-term debt averaging 13 to 15 per cent of total capitalization. For the past 5 years the new funds obtained from net borrowings by these companies averaged 10.5 per cent of their capital expenditures.

These figures are for the 30 highly successful companies. The remainder of the industry, including the thousands of smaller companies and independent operators, borrow higher percentages of their capital needs. Our experience is that many of the independents borrow as much as they possibly can.

Hence, for the domestic industry as a whole, something in the order of 12 or 15 per cent of capital expenditures has been derived from net borrowings; and, if this proportion should continue, the industry in the United States may increase its indebtedness by 1 billion dollars or more per year by 1965.

As to the credit which will be available in the future from the banks to provide their share of these large funds required by the United States petroleum industry, you may judge from the record. During the rapid industrial expansion of the postwar period, the commercial banks of the country responded to the call by increasing their combined total loans from 26 billion dollars at the end of 1945 to a present total of about 76 billion.

From the same period, their total resources were increased from 160 billion to 200 billion dollars today. Thus the banks expanded their resources sufficiently to provide the large increase in credit needed for the postwar industrial expansion; and, whatever the future requirements may be for financing industry, including the petroleum industry, the banking fraternity can be relied upon to be willing and able to grow fast enough to serve all proper banking needs.

Banks change . . . It has been pointed out how the credit rating of the petroleum industry, particularly the producing business, has been greatly improved. The banks have increased their knowledge of the industry, the risks involved and not involved, and have learned how to appraise the situation—in short, how to lend. Several of the large banks have established petroleum departments staffed with competent engineers and other technical men from the petroleum industry, while a number of the smaller banks have retained a petroleum engineer.

The banks have become more aggressive. Time was when the banker sat back behind his roll-top desk and waited for the customer to come in. It was up to the customer to take the initiative. But times have changed. Now the banker has become sales conscious. He understands the customers' problems better, and he goes after the business.

References

1. Frederick G. Coqueron and Joseph E. Pogue, Capital Formation in the Petroleum Industry, Chase National Bank, New York, N. Y., Feb. (1952).

2. Lyon F. Terry and Kenneth E. Hill, "Valuation of Producing Properties for Loan Purposes," J. Petroleum Technol., 5 (7), Sec. I (23-6), Sec. II (5) (1953).

why not

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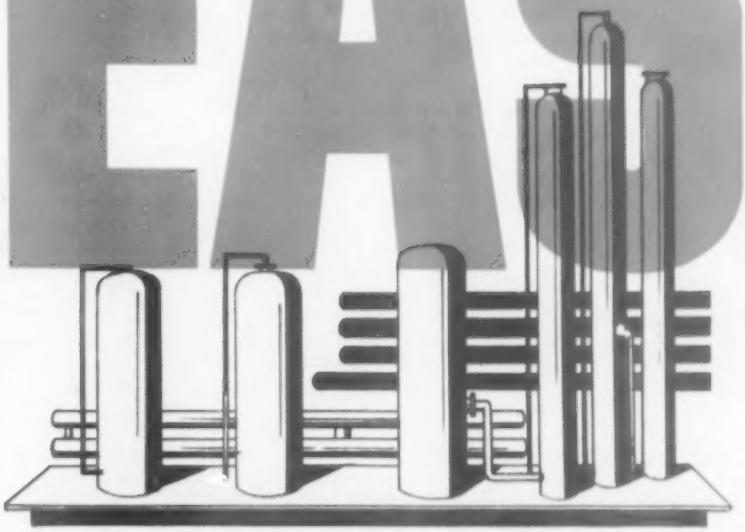

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PIPELINE ARITHMETIC . . .

100 Bbl.
+ 1 Bbl.
? Bbl.

The sum is not 101 bbl. if you're injecting light ends into heavy crude . . . Here's how figures lie.

by H. M. Childress and M. B. Grove

IN recent years crude-oil pipelines have been called on to accept for transport an increasing amount of light products such as butane, natural gasoline, and high-gravity produced distillates. Due to the physical nature of crude-oil systems, and the dispersed receipt points of the light components offered, such products are very seldom segregated and handled separately, but are normally blended into the crude-oil stream. Such blending is actually encouraged. It reduces losses by evaporation of the lighter components and holds to a minimum pump suction difficulties.

As a part of the conservation effort of the pipeline industry the causes of oil losses in transit are being more thoroughly investigated. Such an investigation of the volume loss experienced in systems handling the light components blended into a common crude stream indicated that the losses were not entirely due to increased evaporation. They were partly caused by a phenomenon associated with the blending of the light components and the heavier crude. That is, when a light product such as butane or natural gasoline is mixed with crude, **the resulting volume is less than the sum of the individual component volumes.**

This loss or shrinkage is only an "apparent loss" on a volume basis for there is, of course, no loss of weight as a result of the mixing operation. The shipper recovers the "apparent loss" during the refining of the crude. However, the pipeline has taken receipt of the individual components by volume and delivers out of the system a mixture by volume measurement and thus suffers a real loss in the system balance.

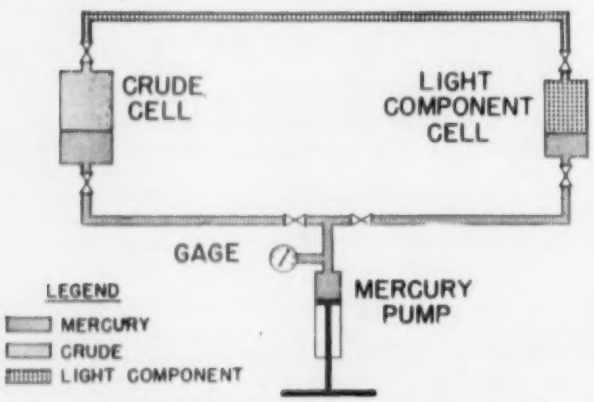
What's gone before . . . This change in total volume on mixing liquids is not a recently observed phenomenon, but has been reported by a number of authors. There are many volume-change data in the available literature on blends of pure hydrocarbons, blends of petroleum fractions, and blends of pure hydrocarbons and petroleum fractions. A review of this information has not revealed any data that could be directly applied to blends of petroleum liquids normally encountered in a crude-oil pipeline.

A study was begun in 1950 to determine the amount and characteristics of the volume shrinkage occurring on mixing crude oil and light components. This study consisted of a series of laboratory tests, a field test, and a theoretical analysis of the experimental data by a consultant, Dr. F. D. Rossini, of Carnegie Institute. The laboratory tests were made to determine the amount of volume shrinkage and the variables affecting the shrinkage. The field test proved that shrinkage was actually occurring in operations. Dr. Rossini analyzed the laboratory data and presented a method of averaging the data for use in estimating the shrinkage losses occurring in crude-oil pipelines.

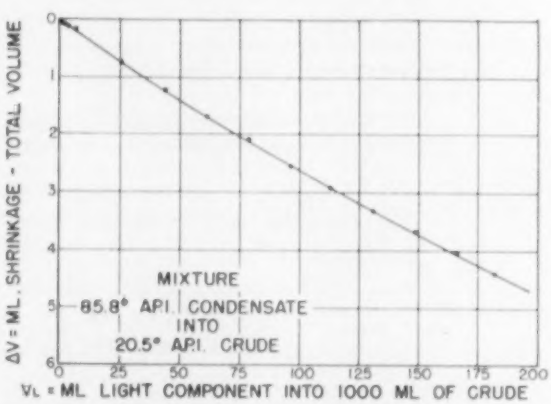
Theory of Shrinkage

The phenomenon of volume shrinkage experienced in blending light petroleum components into crude oil is due to the fact that they do not form ideal solutions. An ideal solution may be defined as one in which no specific forces of attraction exist between the components of the solution and no change occurs in the properties of the components when mixed, merely a dilution of one into the other. Thus, in an ideal solution, the total solution volume is equal to the sum of the volumes of the components and the other physical properties such as refractive index, fluidity, and vapor pres-

Authors are respectively associate engineer and senior research engineer with Interstate Oil Pipe Line Co., Shreveport. Paper was presented by Sam C. Phelps, Interstate's chief engineer at San Francisco A.P.I. meeting, November 14-17, 1955. Paper was also presented at the A.S.M.E., Petroleum Mechanical Engineering Conference, New Orleans, September 25-28, 1955.



EQUIPMENT ARRANGEMENT for making shrinkage tests. Fig. 1.



TYPICAL SHRINKAGE curve obtained in Laboratory tests. Fig. 2.

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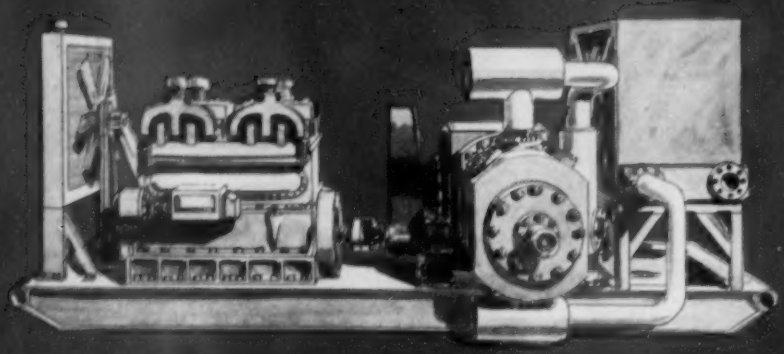
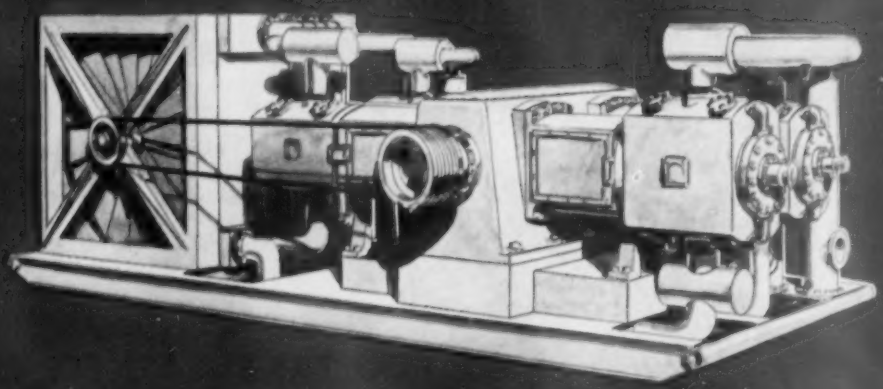


TYPE FMP
independently powered compressor
50 to 150 hp at 300 rpm



TYPE FM-4
rig-powered compressor
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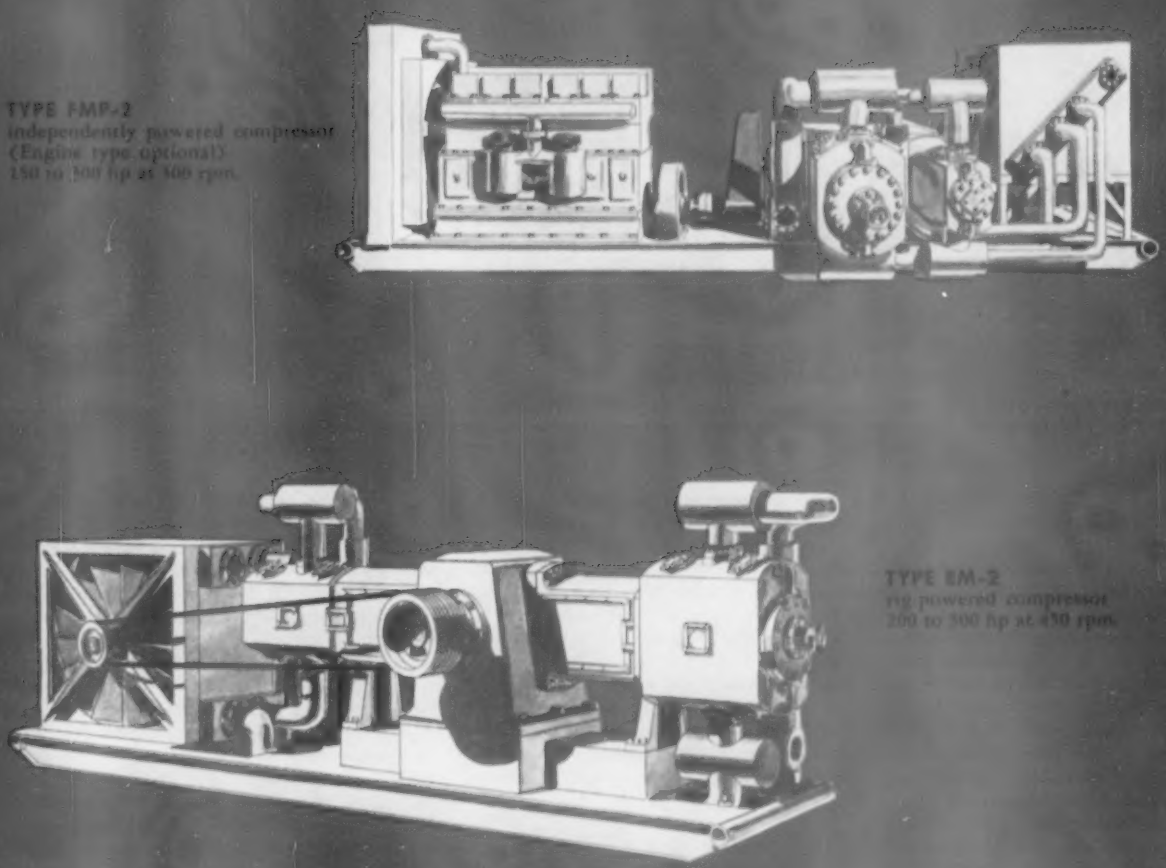

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independently powered compressor
(Engine type optional)
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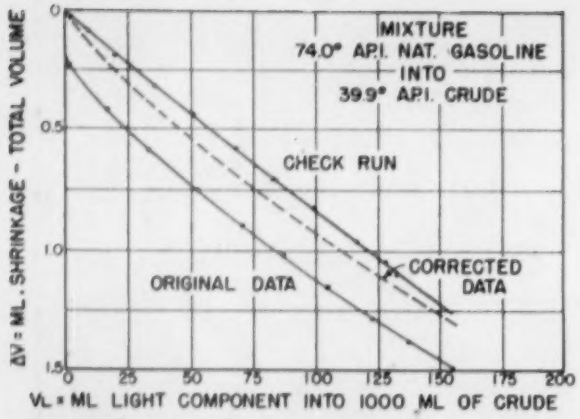
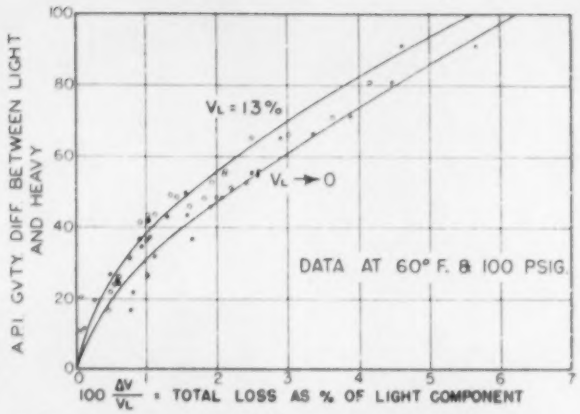


DISCREPANCY IN DATA from early tests was caused by air trapped in test equipment. Lower curve should go through zero on ordinate. Fig. 3.



ROSSINI'S AVERAGE SHRINKAGE CURVES, a method of averaging experimental data using gravity difference between light and heavy components. Fig. 4.

sure can be calculated by taking the molal average of the components' properties.

For a solution to approach ideality, the molecules in the solution must be identical or very similar in size, shape, and properties. If the molecules are identical or very similar, then the environment of the molecules, and hence the forces acting upon the molecules, will be about the same in the solution and in the pure state. If the nature of the molecules of the component should differ appreciably, then deviations from ideal behavior are to be expected and can be observed.

Deviation from ideality as concerns the volume of the solution can be in either a positive or negative direction. That is, it can result in either an expansion or contraction of total volume upon mixing. Glasstone* states that if a solution of two or more components exhibits positive deviation from Raoult's law, the observed vapor pressure and volume would be greater than if the components had formed an ideal solution. This he attributes to the mean attractive forces between the molecules in the mixture being smaller than for the constituents separately.

Most solutions of petroleum hydrocarbons contain a large variety of molecules and, therefore, are seldom ideal. Consequently, it is to be expected that there will always be a change in volume associated with the mixing or blending of petroleum components of varying gravities and molecular structure. Usually, in blends of light components and crudes, this change in volume is negative in direction and results in a shrinkage in total volume.

Laboratory Procedure

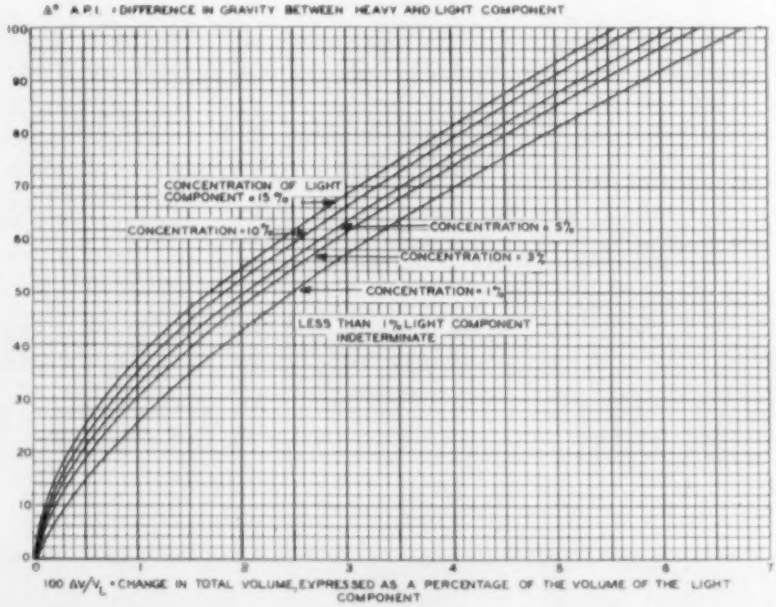
In considering experimental procedures for investigating this shrinkage phenomenon for pipeline purposes, it was found the precision required necessitated the use of a carefully controlled test method. Others who investigated the volume behavior on blending specific hydrocarbons had used a specific-gravity method. By this method known quantities of liquid of known specific gravities are mixed. Then the volume change experienced is determined by comparing the actual measured specific gravity of the mixture against the specific gravity of the mixture calculated as though the solution were ideal.

The need for determining precise data with highly volatile petroleum components blended into crudes at concentrations ranging below 15 per cent was found to be beyond the limits of this test technique. For this reason, a closed-system precision volume - measurement procedure was adopted for the experimental test work.

Equipment and method . . . The laboratory equipment used was essentially the normal pressure-volume-temperature (P-V-T) apparatus used in production work to analyze bottom-hole samples. A schematic diagram of this equipment is shown in Fig. 1.

The volume cells and connecting steel lines were placed in a constant temperature bath. The calibrated mercury pump was left in the open at room temperature. Except for a few special tests, all tests were run at 100 psig. and 60° F.

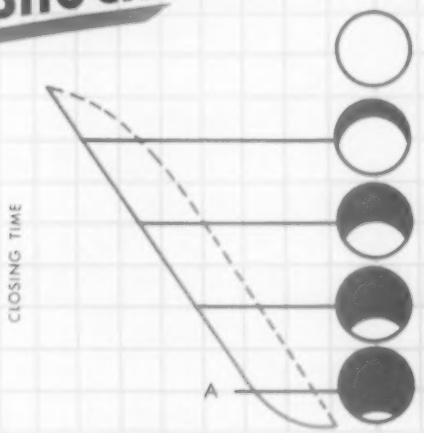
The 60° F. temperature was selected


Δ° A.P.I. = DIFFERENCE IN GRAVITY BETWEEN HEAVY AND LIGHT COMPONENT
CONCENTRATION OF LIGHT COMPONENT = 15 %
CONCENTRATION = 10%
CONCENTRATION = 5%
CONCENTRATION = 3%
CONCENTRATION = 1%
LESS THAN 1% LIGHT COMPONENT INDETERMINATE
100 ΔV/VL = CHANGE IN TOTAL VOLUME, EXPRESSED AS A PERCENTAGE OF THE VOLUME OF THE LIGHT COMPONENT

AVERAGE SHRINKAGE CURVES, made up from test results, are for use by pipeline systems having a variety of crude and light-component injections. Fig. 5.

*Glasstone, Samuel, "Thermodynamics for Chemists."

W-K-M Eclipse Closing . . . takes the SHOCK out of Line Surge



Dotted line shows closing curve of conventional gate valve.

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The no-surging action of eclipse closing is illustrated by the curve above. From full-open to point A, the rate of closing is almost a straight line. From point A (about 70% closed) the rate of close slows as it approaches the fully-closed position. This gradual close-off at the critical point brings the flow through the valve to a smooth stop rather than a sudden halt—consequently there is no surging.

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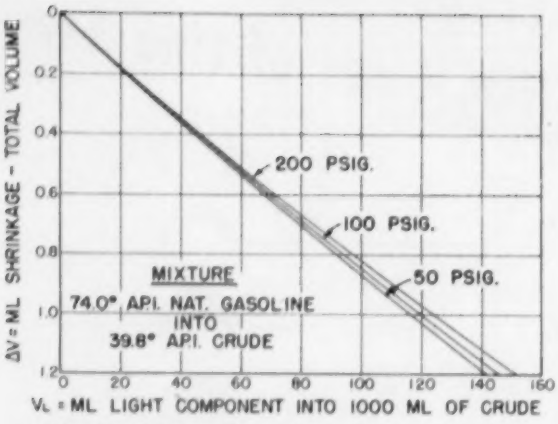
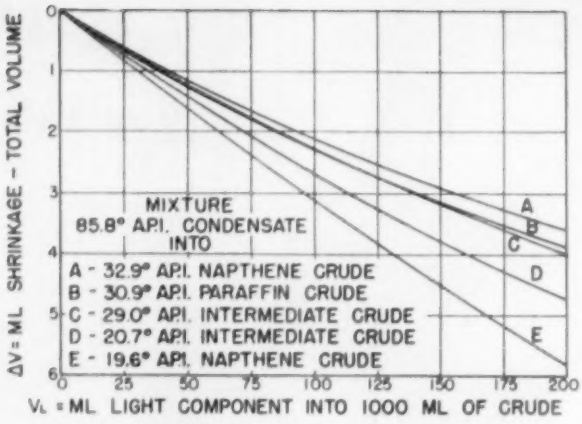
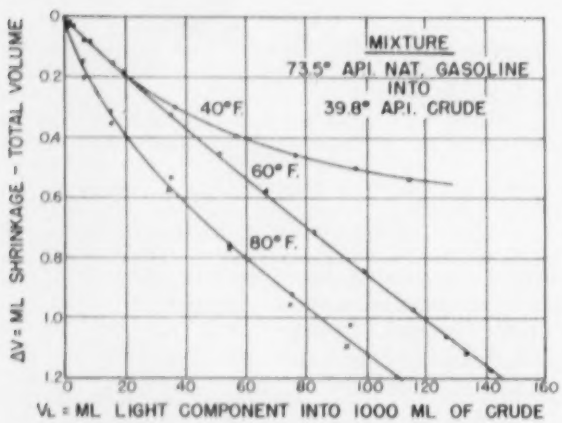


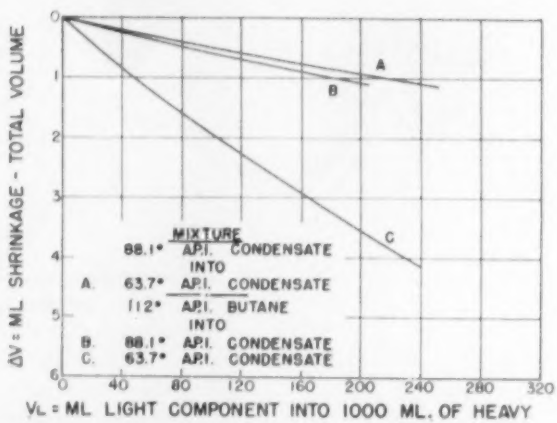
HOW PRESSURE affects shrinkage characteristics. Fig. 6.


ΔV = ML SHRINKAGE - TOTAL VOLUME
MIXTURE
85.8° API. CONDENSATE
INTO
A - 32.9° API. NAPTHENE CRUDE
B - 30.9° API. PARAFFIN CRUDE
C - 29.0° API. INTERMEDIATE CRUDE
D - 20.7° API. INTERMEDIATE CRUDE
E - 19.6° API. NAPTHENE CRUDE
VL = ML LIGHT COMPONENT INTO 1000 ML OF CRUDE

TYPE OF CRUDE can change amount of shrinkage. Fig. 7.



SHRINKAGE is greater as temperature goes up. Fig. 8.



SHRINKAGE between light components is shown here. Fig. 9.

because all field receipts and deliveries are corrected to this temperature. A test pressure of 100 psig. was selected because it would be high enough to prevent vaporization of the lightest components and yet low enough not to cause an appreciable error due to the compressibility of the crude and light component.

The tetsts were run with small incremental quantities of light component injected into a fixed large volume of crude oil. Low percentages of light component were used because the quantities of light component handled by most crude-oil pipelines falls in a range of 15 per cent or less by volume.

To determine the shrinkage, a small measured amount of mercury was removed from the cell which contained the fixed large volume of crude. This was pumped into the light-component cell. This allowed an equal volume of light component to be forced over into the crude cell where it was thoroughly mixed with the crude.

With the constant-temperature system it was possible to determine the shrinkage of the blended volume at the end of each mixing operation by bringing the system up to the test pressure with the mercury pump and noting the change of volume by the calibrated pump. By making repeated injections into the same crude, it was possible to obtain shrinkage data for different concentrations of light component.

Experimental Data

The results of the experimental data obtained by the above test method can be expressed as follows:

Let

V_L = volume of the light component added

V_H = fixed large volume of the crude (heavy component)

V_O = sum of the original volumes of the light component and heavy component

V_M = volume of the resulting mixture

Then the total original volume is:

$$V_O = V_L + V_H \qquad (1)$$

The change in total volume on mixing is:

$$\Delta V = V_M - V_O \qquad (2)$$

The fractional change in total original volume on mixing to form a solution of the given component is:

$$\Delta V / V_O \qquad (3)$$

and the percentage change in total original volume on mixing is:

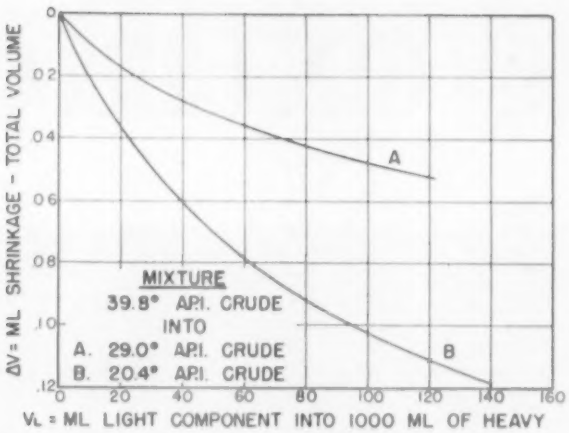
$$100\ (\Delta V / V_O) \qquad (4)$$

The percentage change in volume based on the original volume of the light component is:

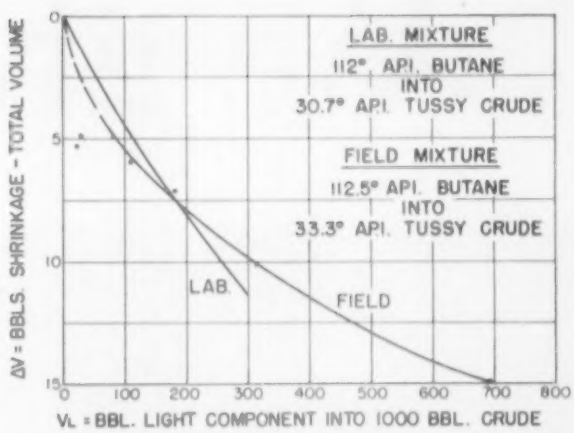
$$100\ (\Delta V / V_L) \qquad (5)$$

Expression 5 gives the change in total volume in terms of volume of light component added.

Plotting the data . . . Fig. 2 is a typical shrinkage curve. This curve shows the loss in total mixture volume on blending incremental amounts of a 85.8° A.P.I. condensate into 1,000 ml. of a 20.5° A.P.I. intermediate-base crude up to a concentration of approxi-



EVEN WITH HEAVY CRUDES of the same base but different gravities, there is shrinkage upon injection of light into heavy. Fig. 10.



CORRELATION OF FIELD AND LABORATORY test results using comparable types of crude and light components. Fig. 12.

mately 15 per cent of the lighter component. The condensate and crude differ widely in characteristics so that a significant loss of volume is noted.

The method of plotting the data used here has been employed for all the initial handling and comparison of data because it reveals inconsistencies in the calculated or observed values of the experimental data. In addition it allows a correlation of the shrinkage witnessed with the concentration of light component added. This is significant in evaluating this problem in a crude pipeline where the light components are considered as the culprits when injected in the crude stream.

A total of 27 such shrinkage tests were run using different crude-light component combinations for each test. In addition a number of these tests were duplicated or rerun in the process of checking irregularities in the data or the effect of other test variables on the shrinkage encountered.

Trapped air causes error . . . In a number of cases of the experimental data, when plotted in this manner, indicated an initial discrepancy. The curve at $V_L = 0$ did not pass through the origin, $\Delta V = 0$ (see Fig. 3, original curve data). Dr. Rossini in his analysis of the data concluded that this was not logical and the curve should be corrected to compensate for this initial discrepancy by raising the curve so that it would pass through the origin as shown by curve—corrected data.

In subsequent tests to determine the cause of this initial error, the laboratory personnel concluded that it was due to the entrainment of minute amounts of air in the system during the charging of the crude into the test cell. Steps were taken to eliminate this error by making minor modifications in the test system and allowing the charged crude cell to set for a time prior to the test to allow entrained air to escape.

It can be noted in comparing the corrected-data curve and the check-run curve, which did not contain the initial discrepancy, that there is a slight difference in the values obtained by the two tests. It was not possible or economical to rerun all blends showing the initial discrepancy. But it is thought that the five corrected curves retained and used have introduced no appreciable error in the summation analysis presented.

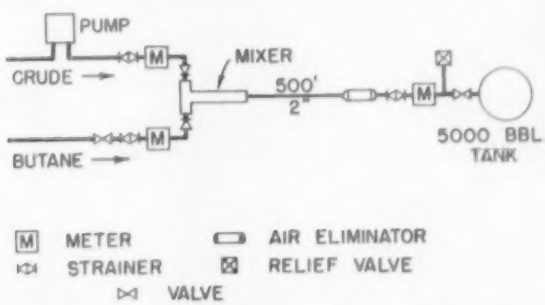
Extending Data

Early in this study the need arose for an index or some correlation between the amount of shrinkage that would occur on mixing petroleum components and some property of the components or the blend. Various physical and chemical properties of the crudes and light components such as vapor pressure, characterization factor, A.P.I. gravity, etc., were investigated.

From a study of the data, the A.P.I. gravity of the components (or more accurately, the difference in gravity between the components) has been selected as the best practical index of the amount of shrinkage that would occur. It was realized, of course, that occasionally blends with the same gravity differential would experience different amounts of shrinkage as the result of the difference in characteristics of the various components.

The use of gravity as an index was further facilitated by the fact that it is the most common and easily obtained characteristic of the components being handled in a crude-oil pipeline system.

Dr. Rossini presented a method of averaging the limited experimental data to cover a wider gravity range of blends. He plotted the gravity difference between the light and heavy components, for two concentration levels of the light component, against the change in total volume expressed as a percentage of the volume of light component. These curves, as shown in Fig. 4, for two concentration values of light component in the mixture, are based on measured values at 13.04 per cent and extrapolated values at infinite dilution, where actual values carry a large uncertainty. This method of averaging the data is good. For use in dealing with a pipeline system a modified form has been prepared; Fig. 5, which presents the values of shrinkage from 1 to 15 per cent of light component in the mixture.



FIELD TESTS using this setup were made to check laboratory results. Fig. 11.

Special Tests

The background of the laboratory test data indicated the magnitude and

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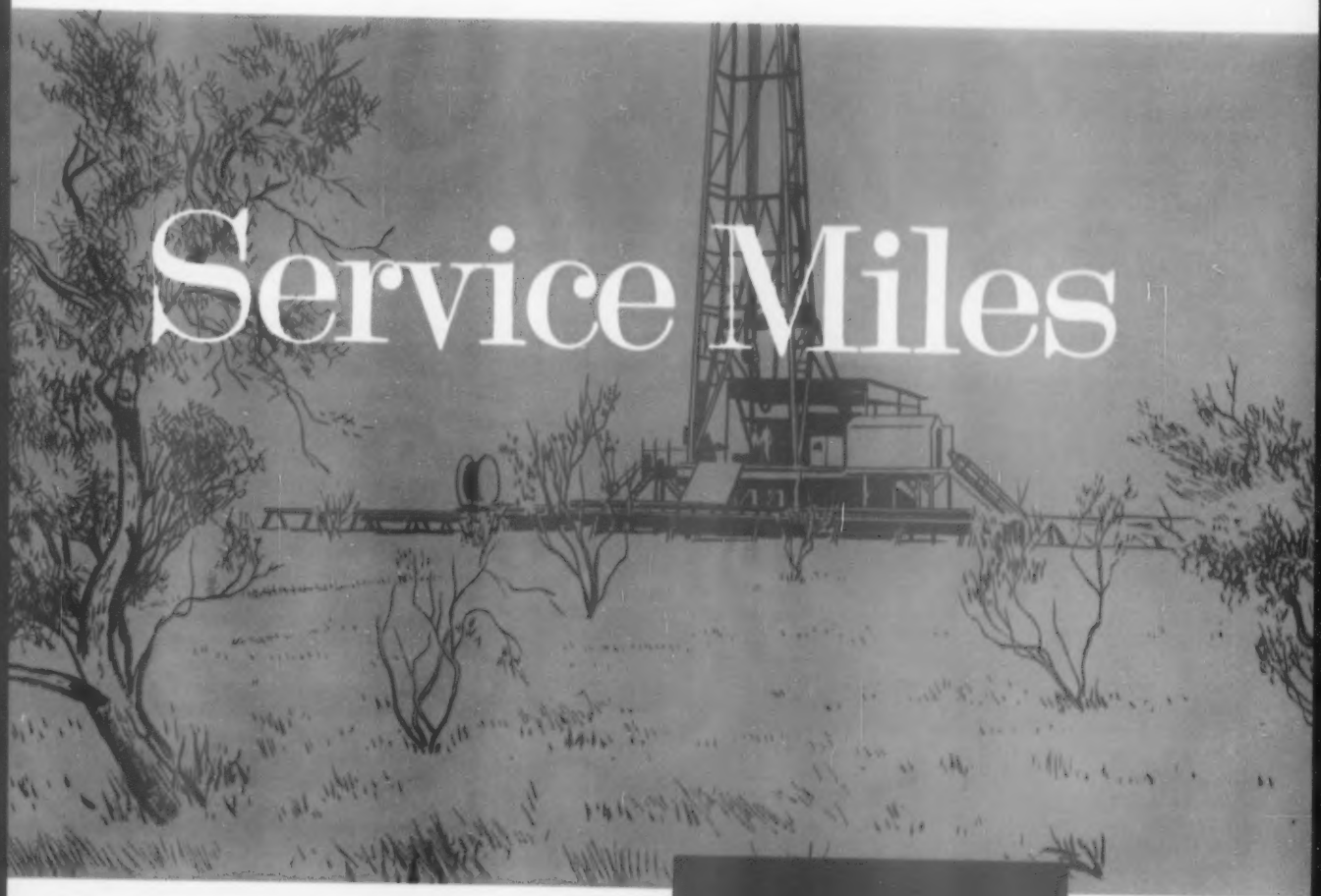

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direction of the volume change on mixing light components in a crude oil. Consideration was then given to evaluating the laboratory data against actual conditions in the pipeline. In discussions with operating personnel, a number of questions arose as to how certain variables such as temperature, pressure, origin of crude, etc., affect the amount of shrinkage experienced. A series of special tests were run to answer these specific questions.

Effect of pressure . . . Two questions regarding the effect of pressure on the amount of shrinkage to be expected in an operating system were considered pertinent. First, the error caused by applying laboratory data obtained at 100 psig. to field conditions where measurements are normally made at atmospheric pressure; and second, the possible effect of high intermediate line pressures on the final amount of shrinkage experienced.

To investigate the first question, three runs were made with the same light component-crude combination, one at 50 psig., one at 100 psig., and one at 200 psig. The results are shown in Fig. 6. All measured volumes were corrected to 100 psig. By doing this, it is believed that the curves as shown exhibit the effect of pressure on shrinkage only, with all errors due to compressibility eliminated.

From these tests, it appears that an increase in pressure causes a corresponding decrease in the amount of shrinkage experience.

To determine the discrepancy of the laboratory data in regard to its application on volumes at atmospheric pressure, and shrinkage values attained were extrapolated to 0 psig. Comparing the values of the shrinkage of total volume at atmospheric pressure with the values at 100 psig., it was found that a correction factor of approximately 1.06 would satisfy the need for applying the laboratory data, within the concentration checked, to field conditions. It is emphasized that this test covers only one light-and-heavy-component combination; other light-and-heavy-component combinations may show slightly different correction factors. In view of the smallness of the indicated correction factor, and until additional test data are obtained which will permit the determination of an average correction factor for a greater range of light-and-h e a v y-component combinations, it is thought that for all practical purposes it can be disregarded.

To investigate the possible effect of high pressure applied on a mixture as it is transported through a pipeline system, a secondary test was made during the 200-psig. run shown in Fig. 6. At a concentration of approximately 108 ml. of light component the pressure was raised in steps to a maximum of 500 psig., then lowered to the same steps to the original 200-psig. test pressure. The volume changes were obtained for each change in pressure as follows:

VARIATION IN ΔV CAUSED BY PRESSURE

Psig.	ΔV, ml. change of total volume
200	0.89
300	1.56
400	2.24
500	2.91
400	2.28
300	1.59
200	0.90

From the above table it can be observed that the only effect of increasing the pressure is to compress the total liquid; upon release of the excess pressure the mixture returned to its original volume. This test indicated, within the accuracy limits of the mercury pump, that no change in the final amount of shrinkage will result from varying line pressure during transit to the delivery point. From a theoretical standpoint, no change should be expected.

Effect of crude "base" . . . It was thought probable that different amounts of shrinkage w o u l d be experienced when the same light component was mixed with a number of crudes of the same approximate gravity but of different composition and characteristics. To investigate this possibility, five runs were made in which the same light component, an 85° A.P.I. condensate, and blended with two different crudes of approximately 20° A.P.I. gravity, and with three different crudes of approximately 30° A.P.I. gravity.

The three crude samples were selected according to "base" as defined by the U. S. Bureau of Mines. This means of selection was thought to assure a maximum known difference in the characteristics of each crude for a given gravity.

The results of these tests are shown in Fig. 7. In comparing these crudes for the influence of "base," no consistency can be found to associate a greater or lesser shrinkage with any particular base crude. In each case the curves consistently show greater shrinkage with a greater gravity differential between the light and heavy components.

Differences in shrinkage between the three approximately 30° A.P.I. crudes could possibly be attributed altogether to the difference in gravity, rather than any difference in base. The difference in shrinkage for the approximate 20° A.P.I. crudes is much larger than for the approximately 30° A.P.I. crude and is thought to be due to fundamental differences in the characteristics of the crudes.

An extensive test program would probably be necessary in order to accurately determine the effect of base of crude on the amount of shrinkage involved. If large volumes of blends of light component into low-gravity crudes are made, then specific tests of the actual blends may be of value.

Effect of temperature . . . In an attempt to determine the effect of applying laboratory shrinkage results obtained at 60° F. to field measurements made at the existing oil temperatures, three shrinkage determinations were made, one at 40° F., one at 60° F., and one at 80° F., with the same light-component-and-crude combination.

After correcting the test data for the volume changes due to thermal expansion and contraction, the results were plotted as shown in Fig. 8. The initial 40° F. run has not been presented graphically due to the irregularity of the data. A rerun of the 40° F. test showed a marked difference from the first one and although the shape of the curve is considered unusual, the data have been presented.

These shrinkage curves indicate a progressive increase of shrinkage with increase of temperature. From these limited data it is indicated that temperature has considerable effect on the amount of shrinkage experienced at low concentrations of light components and that a temperature-correction factor may have to be applied to the 60° F. data in calculating the shrinkage for temperatures which differ appreciably from 60° F.

It is emphasized that the temperature curves as shown are based on the tests using one light-and-heavy-component combination and that other crude-and-l i g h t-component combinations could have different temperature-correction-factor curves.

The ability to control all test conditions for tests run at 40° F. has been questioned for the present laboratory apparatus and modification or the specific equipment used is felt necessary if additional low-temperature volume-measurement tests should be run.

Shrinkage Between Similar Components

It was thought that tests to determine the change in volume between different l i g h t components and the change in volume between different heavy components would be of value for comparison with the mixtures of light components with crude. Five runs were made, three combinations of light components and two combinations of heavy components. Results of these runs are shown in Figs. 9 and 10.

TABLE 1—DATA FROM SEQUENCE BLENDING TESTS

Run No.	°A.P.I. of V_L	Volume of light component added to 1,000 ml. of crude: Incremental	Volume of light component added to 1,000 ml. of crude: Sum	ΔV, experimental change in total volume in ml.: Incremental	ΔV, experimental change in total volume in ml.: Sum
1	88.1	48.87	48.87	1.03	1.03
	63.7	46.77	95.64	0.19	1.22
	20.7	47.72	143.36	0.12	1.34
2	20.7	48.19	48.19	0.14	0.14
	88.1	48.10	96.29	0.95	0.09
	63.7	45.00	141.29	0.22	1.31

From these curves it is observed that as long as there is a difference in gravity, a volume shrinkage is to be expected on blending petroleum products in a pipeline. The amount of this shrinkage will tend to increase as the gravity difference between the components blended increases.

Effect of Sequence Blending

From a theoretical standpoint it had been assumed that no difference in the amount of shrinkage could be expected if the sequence of the injections of a number of light components into the same crude was varied. To verify this assumption two runs were made in which approximately 50 ml. of two different light components and 50 ml. of one heavy component were injected in a varied sequence into 1,000 ml. of crude. The results of this test are shown in Table 1.

It can be noted that the total shrinkage of Run 1 and Run 2 is practically the same. The variation of 0.03 ml. is within the range of accuracy of the tests and the slight variation in the volume of the light components added. From this test it is concluded that the sequence of injection has no effect on the final amount of shrinkage experienced.

Field Test

As further proof of the existence of shrinkage and to attempt to check the laboratory test results with an actual field run, a field test was made in which various percentages of butane were blended into a crude-oil stream.

The test installation, as shown in Fig. 11, consisted of three positive-displacement meters and suitable in-line mixers connected so that the crude and butane could be measured independently, then thoroughly mixed under pressure and the resulting mixture measured while still under pressure.

The results of this test are represented graphically on Fig. 12. For comparison, the field results are shown with laboratory shrinkage data obtained using a similar crude-and-butane mixture. The field test data are not consistent at the lower concentrations of butane ($V_L = 80$ or less) which indicates that the accuracy limit of the field test procedure has been reached. Knowing that if no butane were blended in the crude then no shrinkage would be experienced, allows the extrapolation of field data curve from $V_L = 80$ to $V_L = 0$.

The general trend of the field and laboratory curves is similar which presents a correlation of field and laboratory experience.

Acknowledgment

The authors wish to acknowledge the contributions of G. G. Hughes, D. C. McKinley, and W. K. Luse, of Interstate Oil Pipe Line Co., and the personnel of the Carter Oil Co. laboratory who performed the experimental work. Special appreciation is extended to Dr. F. D. Rossini, of Carnegie Institute, for his assistance in the analysis and presentation of the experimental data.

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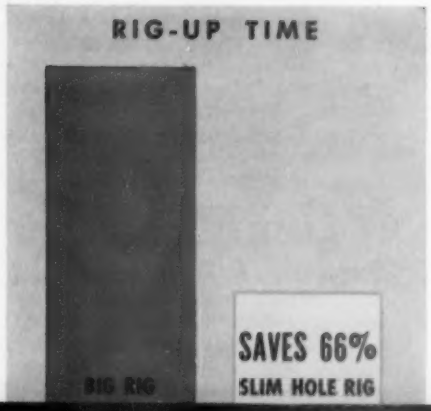
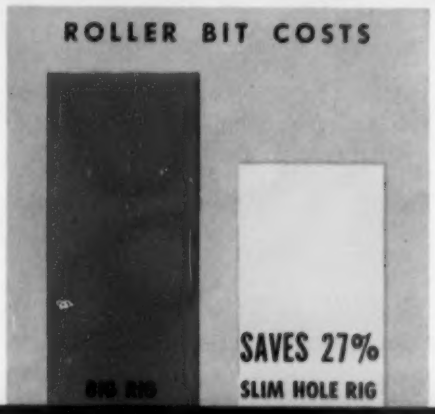
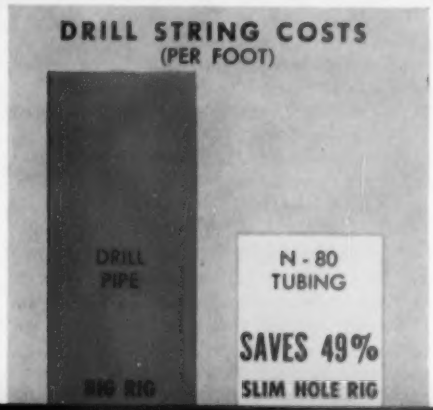


Slim Hole rigs can be rigged up in less than a day's time. In fast digging areas, where rig-up and moving time often consume up to 25% of total well time, a 50% reduction in rig-up time alone could save large sums of money each year.



As a general rule, Slim Hole bits cost 20% to 30% less. Recent bit improvements in Slim Hole sizes appear to be giving almost as much footage per bit as corresponding big bits, making the Slim Hole bit cost comparable, and in many cases less.



In most areas, a tubing drill string should last almost as long as 4½-inch drill pipe, provided the contractor exercises appropriate care. On the average, contractors can expect important savings ranging up to 50% using N-80 tubing.

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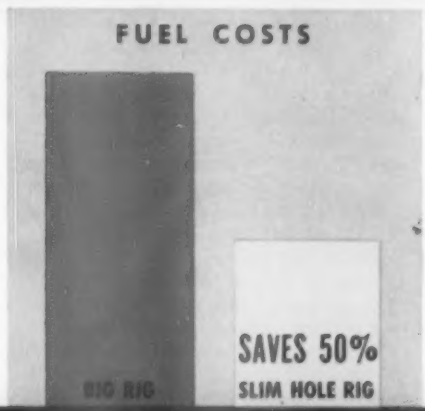
less expensive equipment can lower costs

Smaller rigs require low initial investment, depreciation, insurance, taxes, and maintenance. Such rigs can be operated with 4 and sometimes 3 men—thus reflecting considerable saving in labor. Because of lower daily costs, considerable savings can be effected. As an example, if a "big" rig can drill a well in 10 days, a Slim Hole rig could take 23 days before drilling costs became equal.

Being lighter, smaller, and generally simpler, Slim Hole rigs usually cost considerably less than "big" rigs. Sometimes this cost differential is less than expected because some Slim Hole rigs are wheel-mounted, or self-powered, and often have special equipment to reduce rig-up time. In most instances, a Slim Hole contractor may anticipate a lower capital investment, lower depreciation, and insurance rates.



Fuel savings of 25% to 60% might be expected using Slim Hole rigs, depending on per cent load factor and pump requirements for the given area. Compound Slim Hole rigs rarely need more than half as much peak power as "big" rigs rated for same depth.

Slim Hole contractors report that one-third savings in repair costs might be expected when compared to the larger, more complex mechanism of "big" rigs. This saving depends on drilling conditions, the contractor and his personnel.

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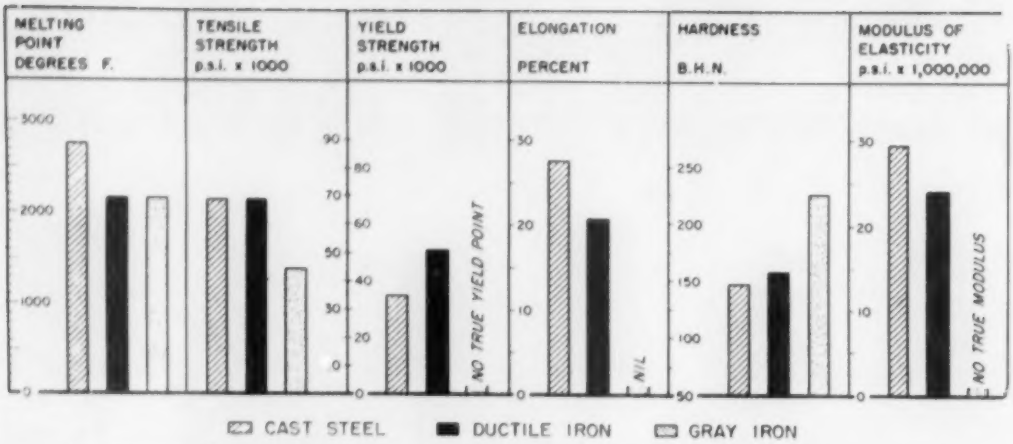


SIX IMPORTANT PROPERTIES of ductile iron compared to those of cast-steel and gray iron. Fig. 1.

Ductile Iron—

A new material for petroleum pipe

Ductile iron compared with gray iron has superior strength, ductility, toughness, a definite and high modulus of elasticity, better machinability for equal hardness, and equal fluidity. Compared with cast steel, it has better castability, surface finish, flexibility of heat treatment, and machinability. These factors result in ductile iron having process advantages of gray iron and mechanical properties similar to steel.

Ductile iron is produced by adding magnesium or cerium or both to liquid cast iron in sufficient amount to cause the graphite to precipitate as spherulites rather than as flakes. Austenitic ductile iron has especially high resistance to corrosion. High-silicon iron is useful in applications requiring high heat resistance.

by Maurice Grandpierre* and C. C. Reynolds†

DUCTILE iron possesses a combination of properties that make it outstanding for many applications in the petroleum industry. The most important combination of properties are ductile iron's high resistance to corrosion and its definite and high yield strength. Other important properties are its process advantages, flexibility of heat treatment, and excellent machinability.

The introduction of ductile cast iron‡ [1,2] in 1948 added an important new material to industry. The purpose of this paper is to define dutile iron as a material and present the status of ductile iron pipe in the petroleum industry.

Massachusetts Institute of Technology has considerable basis for defining ductile iron, because it has conducted research during the past 5 years for Watertown Arsenal[3,4,5] to the end of evaluating ductile iron for possible use as ordnance material. Pont-a-Mousson is one of the largest ductile-iron pipe producers in the world and it has followed many installations to obtain service data and performed extensive tests on commercially produced pipe. All of the pipe discussed in this paper and most pipe produced is centrifugally cast. However, a small quantity of pipe is being produced by hot extrusion.

*Chief engineer, Ductile Iron Division, Pont-a-Mousson Co., Pont-a-Mousson, France, and Pontex Pipe Corp., New York, and †assistant professor, metallurgy department, Massachusetts Institute of Technology, Cambridge.

Paper presented at annual meeting of the A.P.I., San Francisco, 1955.

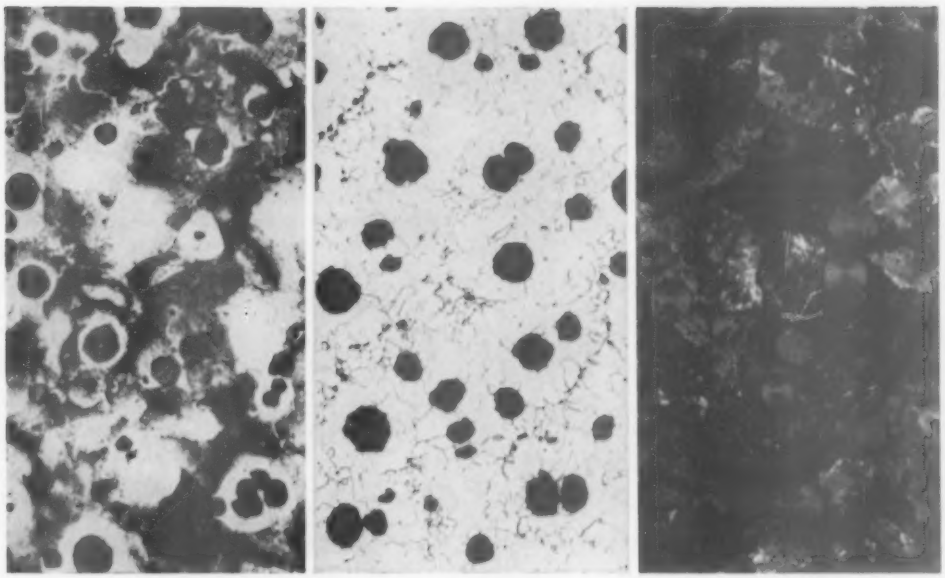
‡Ductile iron is produced by adding magnesium or cerium, or both, to liquid cast iron in sufficient amount to cause the graphite to precipitate as spherulites rather than as flakes.

Mechanical properties . . . Ductile cast iron, being a new material, is best defined by comparing it with the familiar materials, cast steel and gray iron. Ductile iron has a melting point near that of cast iron, which is several hundred degrees Fahrenheit lower than that of steel, and mechanical properties similar to steel rather than cast iron. These relationships are shown graphically in Fig. 1.

Ductile iron is a versatile material. The properties of a ductile iron casting may be tailored by alloying and by heat treatment to a relatively soft, ductile material or to a hard, high-strength material, as required by the application. However, castings are often used in the as-cast condition.

The family of ductile irons consists of any one or combination of the following microstructures: ferrite, pearlite, and tempered martensite. Some typical microstructures are given in Fig. 2. The gray circles are the graphite spherulites and the background is the variable matrix. The range of mechanical properties available is given in Table 1.

To complete the picture a "highly alloyed" austenitic ductile iron, and a high-silicon ductile iron are produced. Austenitic ductile iron is used to advantage in applications requiring its special properties and high resistance to corrosion, whereas the high-silicon iron



As Cast (Ferritic and pearlitic) | Annealed (Ferritic) | Normalized (Pearlitic)

SOME TYPICAL microstructures of ductile iron (100x, nital etch). Fig. 2.

is used chiefly in heat-resistant applications. Pipe for the petroleum industry generally is fully annealed.

Important alloys . . . The interior structure of the annealed metal consists of two materials, iron and graphite. The iron is capable of holding various alloys such as silicon, manganese, and nickel in solid solution; and by proper selection of these alloys the mechanical properties of the iron may be varied over an extended range. For example, ferritic ductile irons of two different silicon content could have the properties shown in Table 2.

The graphite is present as small spheres, about 0.001 or 0.002 in. in diameter, which are dispersed throughout the iron; and the graphite behaves mechanically like an incompressible liquid. Thus, the mechanical properties of the iron are lowered only slightly by the graphite occupying approximately 10 per cent of the space in the casting.

Graphite is beneficial for several reasons: (1) Alloying iron with 3.25 to 3.75 per cent carbon lowers the melting point from 2,800° to 2,100° F. which makes the material easier to cast and clean, and results in finer surface finish and better dimensional tolerances; (2) the graphite precipitates during freezing of the metal, and thereby compensates for some of the shrinkage that is taking place at this time; (3) the graphite spherulites act as reservoirs of carbon and make possible the variety of heat-treated structures with their wide range of mechanical properties; and (4) corrosion resistance is aided by the existence of graphite spherulites.

Workability good . . . Little, theoretically, is known about the corrosion resistance of cast iron; and inasmuch as ductile iron is made of the same components, our information on corrosion will be limited to the empirical type

TABLE 1

Type—	Tensile strength (1,000 psi.)	Yield strength (1,000 psi.)	Elongation (per cent)	Brinell hardness number	Impact*
As cast	70-110	50-90	2-20	160-260	20-110
Annealed	60-80	45-60	10-25	140-200	60-115
Normalized	100-120	70-90	3-10	240-300	35-50
Quenched and drawn	120-150	90-125	2-7	270-350	25-40
Heat-resistant	60-100	45-75	0-20	140-300	5-115
Austenitic	54-74	32-38	4-40	140-200	10-28†

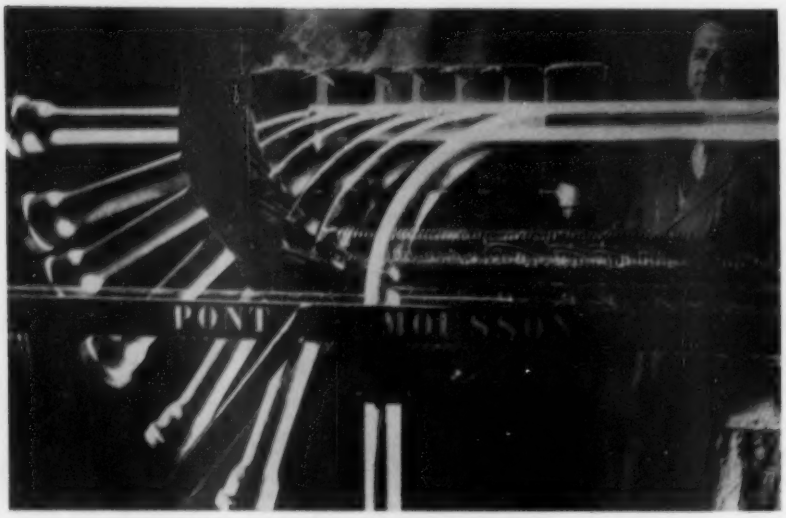
*Unnotched Charpy. †V-notched Charpy

TABLE 2

Silicon content—	1½ per cent	4 per cent
Ultimate tensile strength, psi.	60,000	87,000
Yield strength, psi.	43,000	70,000
Brinell hardness number	130	202
Per cent elongation	23	17
Impact strength (unnotched)	115	20

DUCTILE IRON PIPE ⅛ in. thick and 12 in. in diameter tested to destruction. Maximum pressure of 4,800 psi. Fig. 3.

TEN-INCH ductile iron pipe twisted cold. This figure illustrates the ability of the metal to deform plastically. Fig. 4.



SUCCESSIVE PHASES of hot bending a ductile-iron pipe. Fig. 5.

which is given later. The technique for welding ductile iron is similar to that for cast iron. Satisfactory welds can be made and, if the piece can be heat treated after welding, the weld will have properties similar to the parent metal.

The machining of ductile iron is exceptional when compared with the machining of steel and gray iron. Cutting is by a shear process, as in steel, and a continuous chip is formed. The graphite provides enough lubricant to cut the material dry, but the use of a cutting fluid materially reduces the cutting force.

Strength as pipe . . . The theory of failure in annealed ductile iron has been experimentally checked by W. Clough[6] using loaded, pressurized, hollow cylinders; and his findings indicate that ductile iron follows the maximum shear theory of yielding. Because ductile iron follows this conventional theory of yielding, design engineers can determine the size section necessary to withstand complex loading.

Let us examine actual pipe and specific applications. Fig. 3 shows a 12-in.-diameter pipe that was tested to destruction. The ductile-iron pipe was capable of resisting an internal hydraulic pressure of 4,800 psi. The theoretical pressure the pipe is able to stand is given by the formula :

$$P = 2St/D$$

wherein:

P = pressure, psi.
S = tensile strength, psi.
t = wall thickness, in.
D = outside diameter, in.

or for the pipe in Fig. 3:

$$P = \frac{2 \times 70{,}000 \times 0.375}{12.75}$$

$$= 4{,}100 \text{ psi.}$$

For inspection testing, a stress 60 per cent of the 45,000-psi. specified yield strength, or 27,000 psi., could be used. This results in a test pressure of:

$$P = \frac{2 \times 27{,}000 \times 0.375}{12.75}$$

$$= 1{,}590 \text{ psi.}$$

This calculated test pressure for a ductile-iron pipe of ⅜-in. wall thickness and 12-in. diameter is the same as required by A.P.I. of Grade B, extra-strong, plain-end, steel pipe of ½-in. wall thickness and 12-in. diameter.

Another important factor is the ability of pipe to take long radius bends so that long sections of pipe can be laid, corners turned, and safety obtained in loose or sinking ground. Fig. 4 shows a section of pipe that had slots milled in it and was then cold-twisted. This figure illustrates the ability of the metal to deform plastically. For short-radius bends it is possible to hot-bend the pipe as shown in Fig. 5. Impact resistance is good, as shown by Fig. 6 which shows an 8-in. pipe that has received repeated impacts from a 3-ton weight dropped from a height of 20 ft.

Corrosion Tests

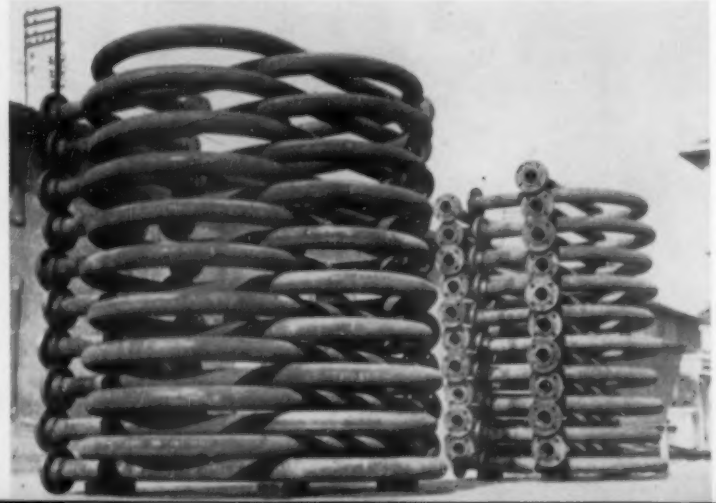
Data on corrosion of materials are difficult to use because so many factors affect the corrosion rate. Surface finish, concentration of corrosive medium, motion of medium, temperature of test, and duration of test are some of the factors that have to be considered. Therefore, specific tests and applications should be considered on a comparative basis.

To test the comparative corrosion resistance of gray and ductile iron, pipe was buried horizontally at 1 m. depth, in beach soils at locations where the pipe would be completely exposed at low tide and completely submerged at high tide. Pipes were placed at two beaches and left three years. The results are shown in Table 3.

Also, samples of the pipe were dipped

EIGHT-INCH ductile-iron pipe after repeated impacts from a 3-ton weight dropped 20 ft. Fig. 6.

DUCTILE-IRON heater coils for an oil tanker. Such coils are usually replaced after 2 years of service owing to corrosion, but ductile-iron pipes show no appreciable corrosion after 3 years. Fig. 7.



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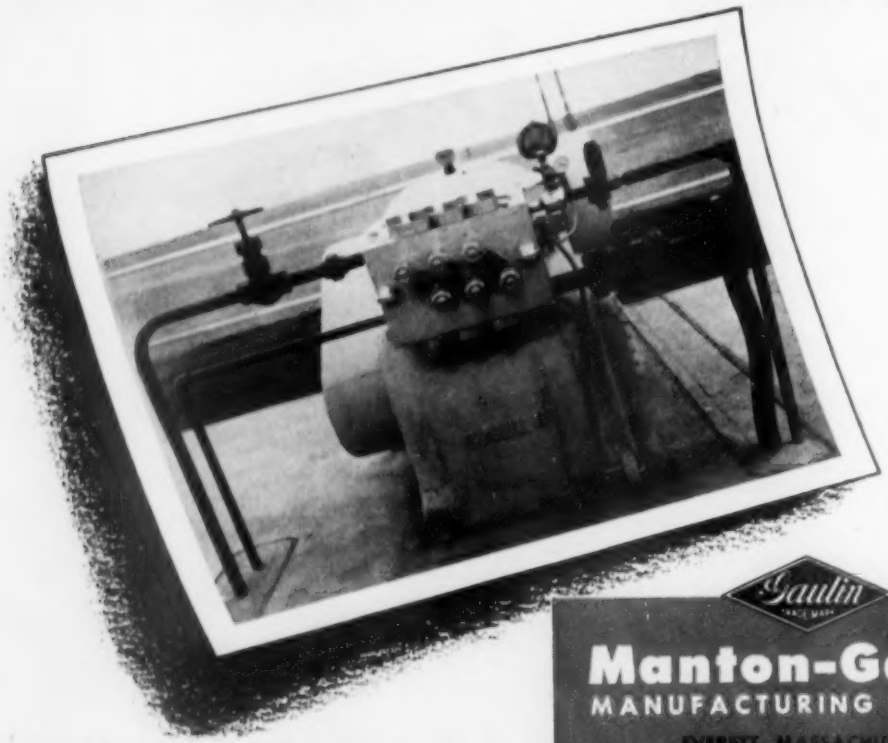

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in sea water on a 20-minute cycle and after 6 months no difference in corrosion was found between the gray and ductile-iron pipe.

Highly corrosion resistant . . . Table 4 lists the results of a year's tests on different pipe material where sea water and crude oil were alternated every 3 weeks and the pipes were flushed by sea water at 140° F. each time a change occurred.

A limited amount of data is also available on samples of different materials corroded in various acids and bases. Each sample was approximately 1½ in. square and ⅛ in. thick. They were placed in large vessels containing the corrosive media at a given temperature for the specified time. Table 5 lists the results.

Service as pipe . . . One interesting application of ductile iron, based on its resistance to salt water corrosion, is reheater coils for tankers, Fig. 7. Steel reheater coils usually are replaced after 2 years of service owing to corrosion, whereas ductile iron pipes, after 3 years, show no appreciable corrosion and it is not yet known when or if they will have to be replaced because of corrosion.

Two other applications of ductile-iron pipe are a high-pressure gas pipeline which carries crude refinery gas and filling pipes on tankers. The gas pipeline is 6 in. in diameter, has a working pressure of 425 psi. and was tested at 850 psi. It runs from Frontignan to Sete in France, which is a distance of about 2½ miles. Twenty-five tankers are also equipped with ductile-iron filling pipes.

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TABLE 3—MAXIMUM DEPTH OF PITTING

	Inches
A. "Le Touquet" Beach, France:	
Gray iron	0.069
Ductile iron	0.047
B. Mont St. Michel Beach, France:	
Gray iron	0.043
Ductile iron	0.045

TABLE 4

Material—	Wt. loss, mg./dm.²/day	Max. depth of penetration (in.)
Tube steel	10.5	0.020
Gray iron	7	0.004
Ductile iron	5	0.00+
Austenitic ductile iron	1	0.00+

TABLE 5

Material—	Corrosive conditions: 5 per cent H_2SO_4 68° F. 8 days Mg./cm.²/day	44 per cent H_2SO_4 226° F. 1 hour Mg./cm.²/hour	30 per cent HCl 68° F. 1 month Mg./cm.²/day	50 per cent HCl 221° F. 1 hour Mg./cm.²/hour	30 per cent NaOH 68° F. 1 month Mg./dm.²/day	30 per cent KOH 68° F. 1 month Mg./dm.²/day
Strip steel		1,250		1,060		
Gray iron	279	470	500	450	3.6	3
Ductile iron	108	385	150	496	3.2	2.5
Stainless steel 18/8	3	12	25	671	0.25	0.2
Austenitic ductile iron	12	4	0.2	25.7	1.2	0.05

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Two for the Money—

Gasoline and motor oil work hand in glove

by Howard G. Vesper

An effective fuel-lube combination has been developed in the past 10 years to meet the requirements resulting from engine-design advances and changed operating conditions. Specific improvements have included increased octane and reduced sulfur levels of gasolines, use of more effective additives in both gasoline and oil, and the development of multigrade oils. Newly developed lubricating-oil additives can be expected almost to eliminate engine-sludge formation in the near future. This is a challenge to the marketing side of the industry to sell the new concept of the fuel-lube package.

THE past 10 years have witnessed the development of a new era in passenger-car design. This is an era of "big, luxurious" cars. The 250-hp. automobile is no longer a novelty. The so-called "popular" cars (Chevrolet, Ford, Plymouth) now boast of power plants which can develop 160, 180, and even more than 200 hp.

Indications are that this trend in increased horsepower will continue for all makes in 1956 and beyond. These new cars are often equipped with air conditioners, power steering, power brakes, automatic transmissions, and many other features for convenience and driver comfort.

Loads have increased . . . This new age began with the general adoption of the high-compression, high-speed V-8 engine and the automatic transmission. Since 1946 the number of cars on the road has about doubled. Increased suburban living has caused greater use of the family car for commuting. Although considerable improvement has been made in highway facilities, cars operate much of the time under highly congested stop-and-go conditions, with occasional periods of high-speed driving.

These circumstances impose severe requirements on the gasoline and lubricating oil, and the cars of today are possible only because the petroleum industry has kept pace with higher-quality products. With these developments has come a growing interrelation, qualitywise, between gasoline and motor oil when used in modern, high-compression high-speed engines.

Performance controlled . . . There are four principal factors influencing the performance of the modern passenger-car engine: engine design; operating conditions, including maintenance; quality of gasoline; and quality of motor oil. Each of these is important in itself, but its influence is modified greatly by each of the others.

The petroleum industry has direct control over the quality of gasoline and the quality of motor oil and, within limits, can influence operating conditions through advice to the user. There is little the oil industry can do about engine design.

Author is vice president, Standard Oil Co. of California, San Francisco. Paper presented at annual meeting, A.P.I., San Francisco, November 16, 1955.

This discussion will be confined principally to performance factors directly related to both gasoline and motor oil. By way of preface, however, I wish to review briefly some of the engine-design changes which have influenced gasoline and lubricating-oil developments.

Engine design . . . In 1946 the average advertised horsepower of the three "low-priced" cars (Chevrolet, Ford, Plymouth) was 92 hp. (see Fig. 1). In 1955 the average of the three V-8 models of these engines is 162 hp., an increase of 76 per cent. The average horsepower of models in the "high-priced" field (Cadillac, Chrysler, Lincoln, and Oldsmobile) has increased from 128 hp. in 1946 to 232 hp. in 1955. These makes were selected only to illustrate the trends which have taken place. The significant fact is that the "popular" car engine is now equal in horsepower to the average of the "big" cars of 4 years ago.

This increase in power has been achieved primarily by increasing compression ratio and engine speed. In addition, multibarrel carburetors, new manifold designs, and high-lift cams have all contributed. It is interesting that this increased horsepower has been achieved with relatively small change in engine size.

To the petroleum refiner, the change in compression ratio is the most important because of its effect on the octane level of the gasolines required by these new engines. Fig. 2 illustrates the change in compression ratio for the

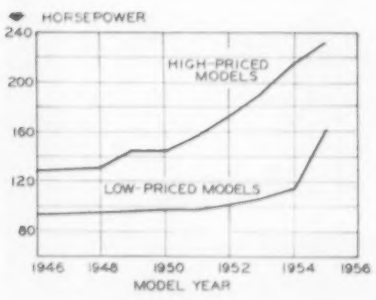


Fig. 1
MORE POWER for today's cars has been brought about by . . .

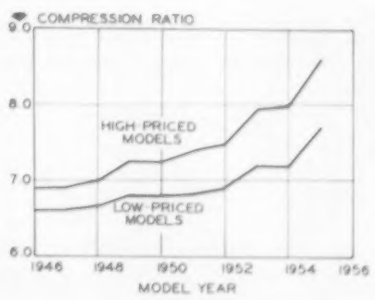


Fig. 2
HIGHER COMPRESSION engines, but this has required . . .

Fig. 3
INCREASING OCTANE of gasoline to keep the cars running.

same models of cars represented in Fig. 1. The sharp increase in the compression ratio of "low-priced" cars in 1955 has been coincident with the general adoption of V-8 engines. Now the compression ratio of these cars is equal to that of the "big" cars of a very few years ago. In the "high-priced" field the average compression ratio is approximately 8.5:1, a ratio which several years ago would have been considered experimental only.

Higher octanes . . . The effect of these changes in compression ratio has been to increase the basic octane requirement of the engines. Fig. 3 shows that the octane number required to satisfy 90 per cent of all passenger-car models manufactured in 1946 was approximately 90 [A.S.T.M. octane number (D 908, research method)], and for cars manufactured in 1955 the corresponding octane level is 95.

Although the increase is only five numbers, it must be remembered that octane numbers in this range are very costly to produce. In the 90-to-95 octane range, an increase of one octane number costs the refiner approximately 2 million dollars in plant investment for a refinery processing 100,000 bbl. per day of crude oil. In addition to the plant investment, an increase in yearly operating cost of approximately the same magnitude is incurred for each higher octane number produced.

Engine conditions . . . The changes in engine design have been accompanied by marked changes in driving conditions. Speeds on the open highway are considerably higher than those 10 years ago. On the other hand, traffic density has increased so that 18 per cent of average city driving occurs under idling conditions and 18 per cent under deceleration. More and more, the family car is being used for short trips.

Published figures show that approximately 38 per cent of both city and rural trips are less than 3 miles and 55 per cent less than 6 miles in length. The net result of this heavier traffic is that only a small fraction of the available horsepower is used. This is illustrated in Fig. 4, which compares the relative horsepower available in a modern passenger car to that required for steady-speed, level-road operation. In the low-speed range only a small fraction of the available power is normally used and, even at high speeds, only a moderate proportion of the available power is needed.

Low engine output during short trips with many stops and starts results in low engine temperatures, a condition which is conducive to high wear and formation of deposits. A typical operating-temperature history of a car is shown in Fig. 5. Although the jacket temperature reached the thermostat control limit after only 3 miles of stop-and-go city driving, the oil temperature was only 110° F. This temperature is well below the temperature at which blowby gases condense to form sludge and acids which damage working parts of the engine.

The petroleum industry has made advances in the quality of gasolines and lubricating oils which have offset, to a large degree, the harmful effects of operation at low engine temperatures; thus these modern engines provide the performance expected and life desired by the owner. I shall dwell only briefly on these extensive advances although they are the essence of this fuel-lube partnership and the basis for a new marketing concept.

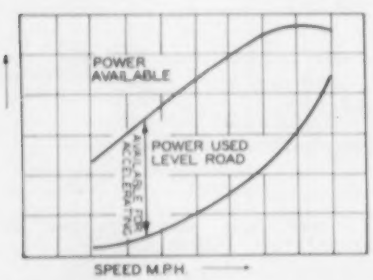
Recent advances . . . The increasing octane requirements have been met by a continual increase in the octane levels of gasoline made available by the petroleum industry. Today gasolines are available in a wide distribution which will satisfy all of the cars on the road, with the exception of a few so-called "mavericks." Further advances will be required as compression ratios are increased. It is one of the main objectives of the petroleum industry to be in a position to meet these new requirements.

Ten years ago engine life before overhaul was often limited to approximately 35,000 miles to 50,000 miles by wear and deposits which resulted in high oil consumption. Lubricating-oil compounds are effective in minimizing wear and deposits, and the trend since 1946 has been toward higher levels of more effective compounding, as illustrated in Fig. 6. This change in level has resulted in more than doubling the engine life by reducing wear and deposits in the ring-belt area, even though design and operating conditions have become increasingly severe.

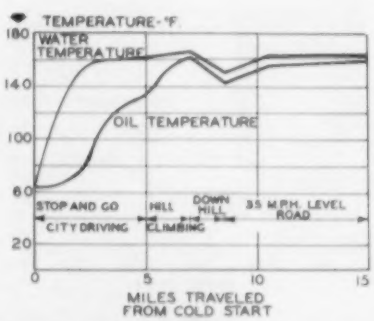
Although we have extended engine life in terms of oil consumption, the modern car has many other mechanical features, such as hydraulic valve lifters, which are critical to wear and deposits and require an even more highly and somewhat differently compounded oil for adequate performance. The petroleum industry met this need by increasing compounding levels.

The length of time that lubricating-oil compounding is effective in controlling wear and deposits depends upon the rate at which oil becomes contaminated with products of combustion. The sulfur compounds formed in combustion are among the most harmful to the additive life of lubricating oil. Fig. 7 shows the relationship between the sulfur content of motor gasoline and lubricating-oil life.

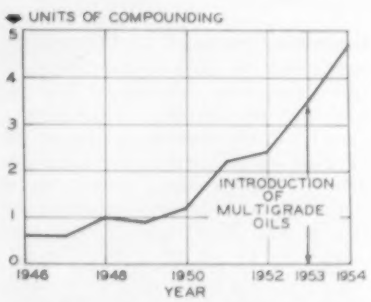
A few years ago 0.25 per cent of sulfur, or even higher, in gasoline was normal in many areas. The most modern refining methods have reduced sulfur in gasolines by measurable amounts, and today levels of 0.1 per cent or



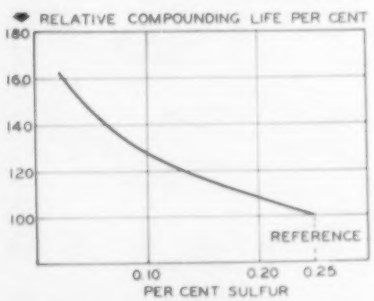
EXCESS POWER available in today's passenger cars. Fig. 4.



ENGINE TEMPERATURE conditions for typical suburban driving. Fig. 5.



INCREASED COMPOUNDING of motor oils has resulted in longer engine life. Fig. 6.



HOW FUEL SULFUR affects motor-oil compounding life. Fig. 7.

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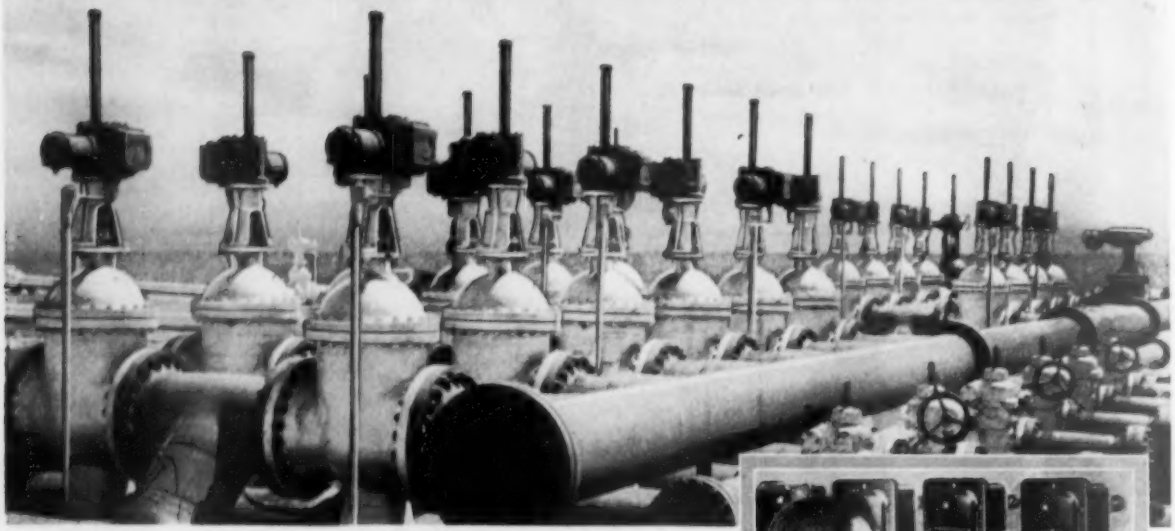

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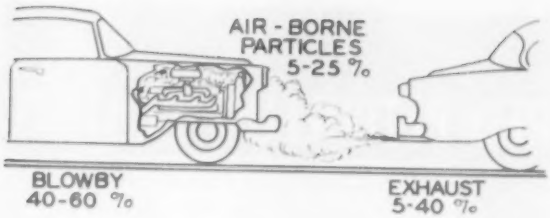


SOURCES of carburetor gum and deposits. Fig. 8.

lower are not uncommon. This reduction in sulfur, together with the higher levels of lubricating-oil compounding, meets the higher service-performance requirements and gives "plus" protection against wear and deposits. However, maximum benefits can only be obtained with realistic drain periods.

Other improvements . . . The advances in gasoline and lubricating-oil quality discussed thus far have resulted from the application of principles generally established throughout the industry. Continued research on petroleum-product performance along newer, more advanced lines has resulted in additional quality improvements which are of benefit to the user not only in extended engine life, but in reduced operating cost. Multigrade oils and "improved" gasolines are the two outstanding examples of this.

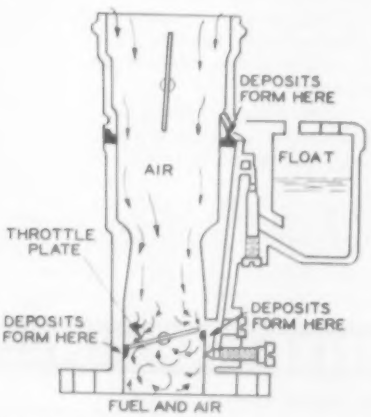
The increased traffic driving, combined with the complexities of the modern carburetor, has aggravated the problem of carburetor gumming which, in the past, was the main reason for carburetor overhauls. Carburetor deposits are the result of the engine's breathing air-borne particles, exhaust gases from other cars, and blowby products from its own crankcase. Fig. 8 shows the relative estimated contribution of each of these constituents to carburetor deposits.

As these materials pass through the throat of a carburetor, as shown in Fig. 9, they are deposited by centrifugal force on the walls of the throttle body adjacent to the throttle plate when it is in the idle position. The effects of these deposits are rich idling, rough running, and stalling at low speeds. The net result is faulty operation and loss in gasoline mileage. This problem has been solved by the development of improved gasolines which remove these deposits.

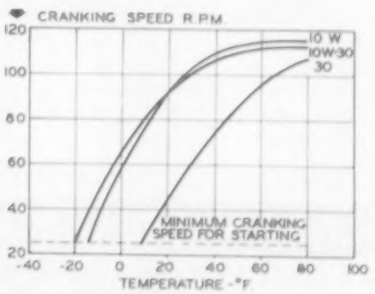
Multigrade oils suitable for year-round use were introduced in 1953. These oils have the property of combining the low-temperature characteristics of 10W conventional lubricants with the oil-mileage characteristics of the higher S.A.E. grades. This viscosity characteristic results in reduced engine friction, which is responsible for the savings in gasoline mileage as compared to conventional oils of the higher S.A.E. grades.

These oils also have a beneficial effect in retarding the formation of combustion-chamber deposits, thereby reducing the octane-requirement increase. They generally contain a higher level of compounding than most conventional oils offered at retail outlets and, along with the more rapid circulation in an engine, tend to provide better engine cleanliness.

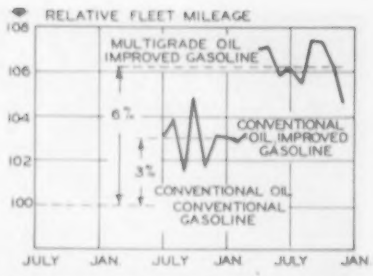
Multigrade oils are particularly effective in reducing starting difficulties at low temperatures—a problem aggravated by increased outdoor overnight parking—and are effective in achieving a more rapid warmup because of the reduced engine friction. Fig. 10 compares the cranking speed, at various temperatures, of a 10W-30 multigrade oil with the cranking speeds (also at various temperatures) of an S.A.E. 10W oil and a 30-grade conventional lubricant. With gasolines of proper volatility, multigrade oils permit easier starting at low temperatures.



IDLING POSITION of carburetor where depositing is worst. Fig. 9.



EFFECT of motor-oil weight on engine cranking speed. Fig. 10.

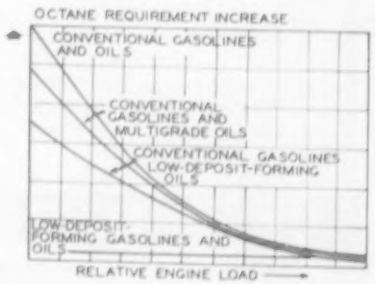


MILEAGE BENEFITS obtained by a large taxi fleet using the improved fuel-lube package. Fig. 11.

The fuel-lube combination . . . Improved gasolines increase mileage by eliminating rich idling. Multigrade lubricating oils increase gasoline mileage by reducing engine friction. When improved gasolines and multigrade oils are used together, the customer receives maximum benefits. Fig. 11 shows the increase in gasoline mileage achieved in a taxicab fleet with this combination. The relative average fleet mileage was increased by 6 per cent with an improved gasoline and multigrade lubricating-oil combination as compared to that with a conventional gasoline and lubricating oil.

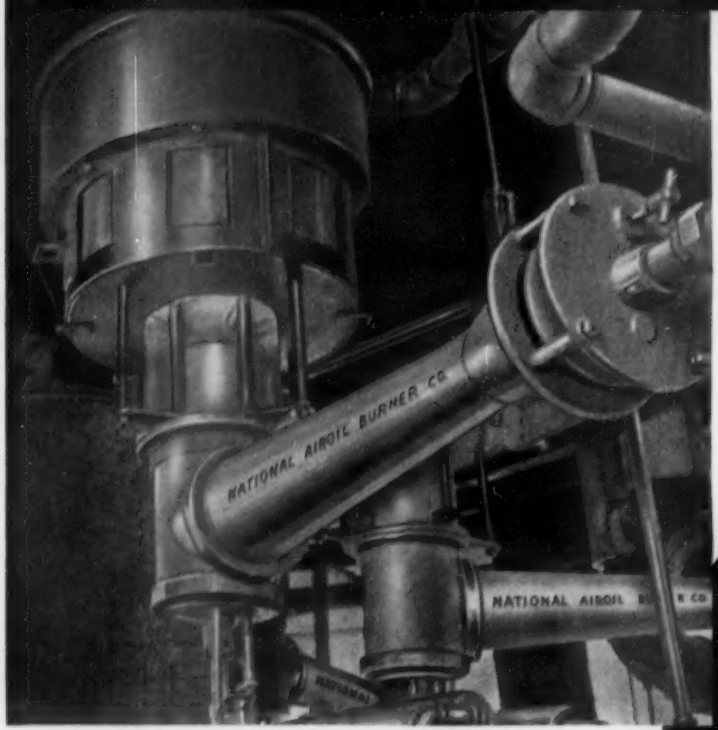
It is of interest that this increase was split approximately equally between the two improved products. The gain which resulted from the multigrade oil was minimized by the operating conditions of the fleet. Gains in gasoline mileage from the lubricating oil of from three to five times that illustrated have been obtained under operating conditions encountered frequently by the average motorist. These benefits, when applied to a taxi fleet of 500 units, resulted in a monthly saving in petroleum and maintenance cost of approximately $2,000.

Both gasoline and lubricating oil affect octane requirements. Fig. 12 shows this combined effect under various conditions of engine load. The maximum octane-requirement increase occurs with conventional gasolines and lubricating oils under very light-load conditions, and the maximum benefit from the use of multigrade oils also occurs

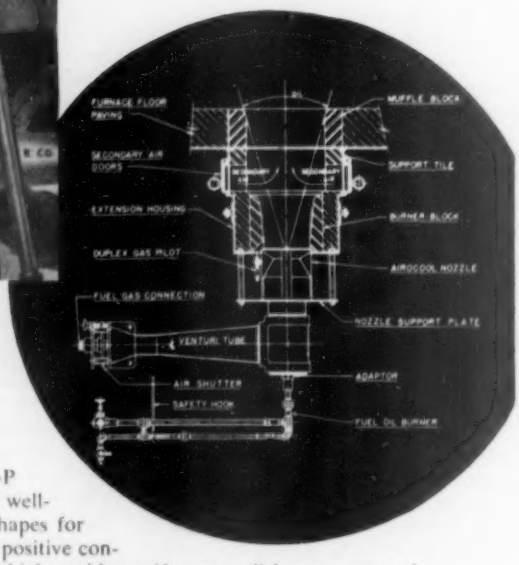


HOW OIL AND GASOLINE affect octane requirement increase. Fig. 12.

Designed for VERTICALLY FIRED PETROLEUM HEATERS



NATIONAL AIROIL VERTICAL Oil-Gas Tandem Combustion Units



many more hours on stream, without forced shutdown

Exclusively for vertical firing, National Airoil VERTICAL C-P Tandem Block Units retain all the features of our regular well-known Tandem Units . . . plus: special pre-cast refractory shapes for easier installation and maintenance; secondary air louvres for positive control of flame pattern; and an all steel duplex detaching gear which enables swift, easy, oil burner removal.

VERTICAL C-P Tandem Units hold air in the combustion zone until fuel and heated air are thoroughly mixed. This means that ignition takes place in a hot zone; the result: high fuel economy through more rapid combustion with a minimum of excess air. NATIONAL AIROIL's patented Tandem Combustion Blocks allow secondary air to be easily and accurately controlled. By adjusting air control louvres, flame can be shaped to radiate heat uniformly without tube impingement.

ALL VERTICAL Tandem Units are fired with NATIONAL AIROIL Combination Oil and Gas Burners . . . have a high turn down ratio with steady flames . . . maintain high flame temperatures using either fuel oil or gas. With the C-P TANDEM UNIT's clean flame, a cold furnace can be brought to full capacity in a shorter time.

"Many, many more hours on stream, without forced shutdown" . . . yes, YOU will realize high profits from YOUR heaters when National Airoil C-P VERTICAL Tandem Units are specified. Our new folder 498 is yours for the asking.

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INDUSTRIAL OIL BURNERS, GAS BURNERS, FURNACE EQUIPMENT

under these conditions. With an oil which does not contribute to combustion-chamber deposit, a still further reduction in octane-requirement increase is achieved, even with conventional gasolines. The ideal combination is one in which neither the fuel nor the lubricating oil contributes to combustion-chamber deposit under any operating conditions. This is illustrated by the lower curve obtained with an experimental fuel and lubricating-oil combination, although such products are not commercially feasible at this time.

The effect of engine load on octane buildup accounts for the inconsistencies reported throughout the industry as to the benefits obtained with multigrade oil on this performance feature. Our experience shows that a reduction of from two to four octane numbers is possible under many conditions when multigrade oils are used in place of conventional lubricants. Based on the octane costs previously quoted, a 2-number reduction in octane requirement would theoretically offset an investment of approximately 4 million dollars in plant facilities in a 100,000-bbl. per day refinery and, in addition, would provide a nearly comparable saving in yearly operating costs.

Practically, the use of these multigrade oils will permit a further increase in compression ratio, which will result in more power, or greater fuel mileage, to the consumer.

Further developments . . . Although major improvements have been made in the quality of gasoline and lubricating oils, the optiumum has not yet been reached. Two major problems remain: engine sludge under low-load conditions and octane buildup caused by combustion-chamber deposits. It appears that engine sludge will be reduced to a negligible quantity in the relatively near future through the use of a new additive in lubricating oils.

The result of this improvement will be extended control of oil mileage and freedom from the difficulties common to closely fitted parts which are now affected by sludge. In addition, it is anticipated that these oils will not contribute measurably to combustion-chamber deposits and octane-requirement increase.

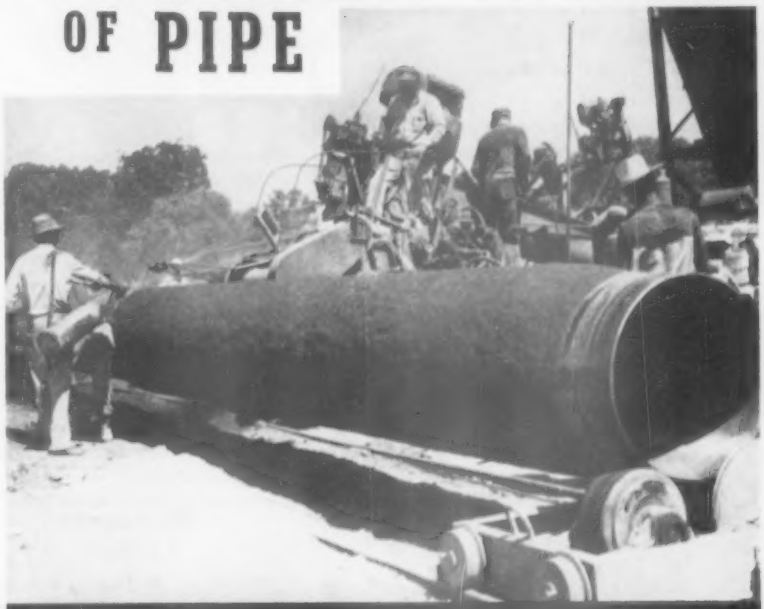
There still remains the problem of developing a commercially feasible gasoline which will not contribute to combustion-chamber deposits. Although this development appears to be possible, it is of a long-range nature. Such a gasoline, in combination with the future lubricating oils, will not only largely eliminate octane-requirement buildup, but will result in even longer engine life and greater benefits to the customer.

Marketing need . . . Technically, the petroleum industry has succeeded in the development of products which, in combination, provide the performance looked for by the customer. There is some question in my mind, however, that it has accepted the challenge involved in marketing this product combination. Perhaps "Operation Two for the Money" may be the theme under which the marketer can undertake promotional programs as productive as the industry's technical and engineering developments.

I might say here that I am not speaking only of marketers who sell both gasoline and motor oil. The single-line marketer of quality lubricants, too, is vitally concerned with the proper fuel-lube combination. The interrelation, qualitywise, of these products makes these developments a general challenge rather than one applying to any particular type of marketer, for even the quality lubricant of the single-line marketer can only give maximum performance when used in combination with a quality gasoline of another marketer.

The marketer has now in his hands a long-sought product combination which gives to the customer not only extended engine life, but also reduced operating costs.

FOR CONCRETE COATING OF PIPE



...on a Production Basis

Half a million pounds a day on 30" pipe is impressive production . . . and that's what ANCHOR-WATE did on a recent job! Concrete coating by men who know from long years of experience, is what you buy at ANCHOR-WATE. It's the dependable answer to pipeline crossings at rivers, on marshy land, etc. If you have a weight problem for crossings, call ANCHOR-WATE.

THE ANCHOR WATE COMPANY

P. O. Box 12185 — 13308 Telephone Road
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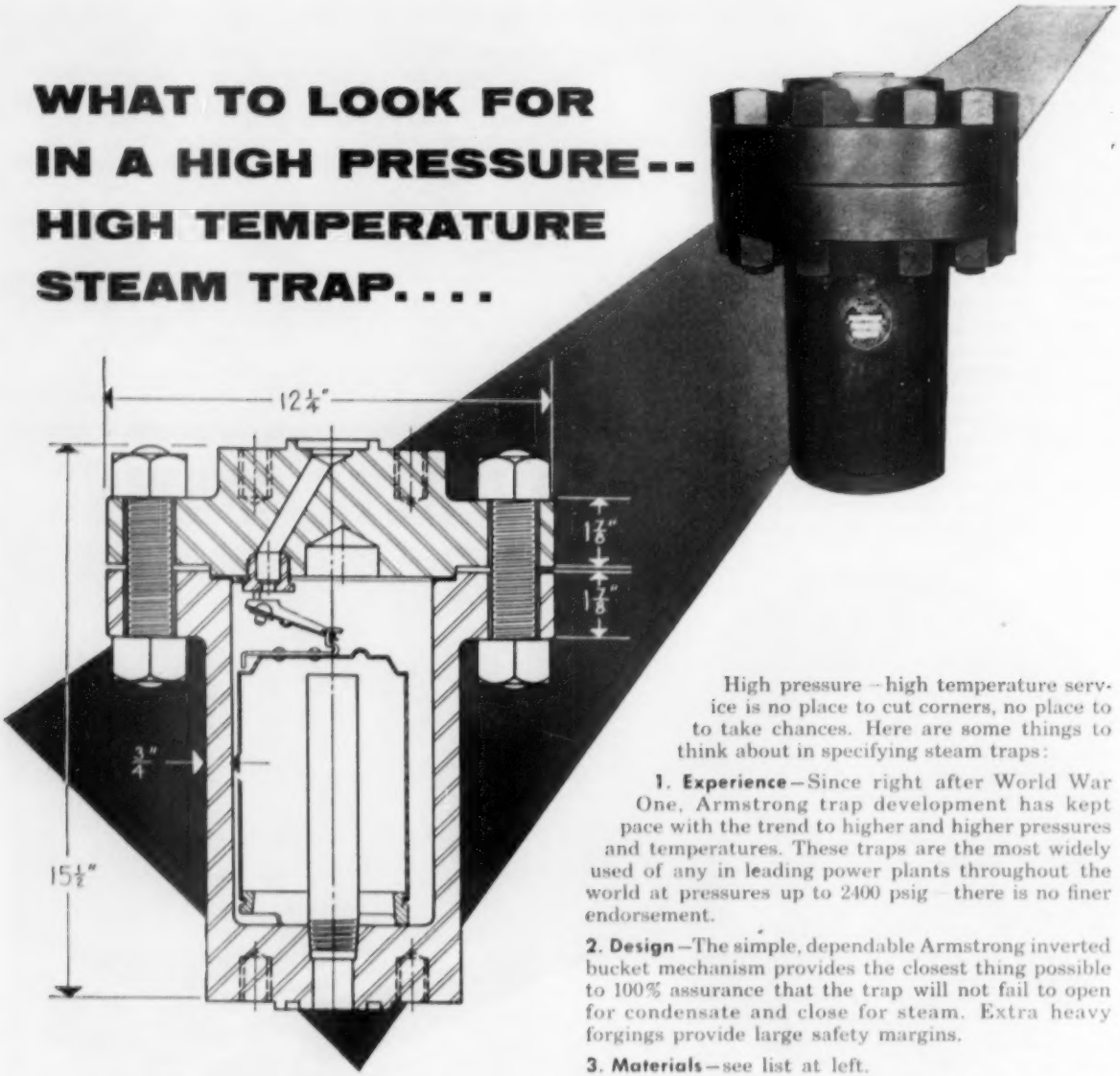
WHAT TO LOOK FOR IN A HIGH PRESSURE-- HIGH TEMPERATURE STEAM TRAP....



High pressure – high temperature service is no place to cut corners, no place to to take chances. Here are some things to think about in specifying steam traps:

1. Experience—Since right after World War One, Armstrong trap development has kept pace with the trend to higher and higher pressures and temperatures. These traps are the most widely used of any in leading power plants throughout the world at pressures up to 2400 psig – there is no finer endorsement.

2. Design—The simple, dependable Armstrong inverted bucket mechanism provides the closest thing possible to 100% assurance that the trap will not fail to open for condensate and close for steam. Extra heavy forgings provide large safety margins.

3. Materials—see list at left.

4. Price—Armstrong forged steel trap list prices range from $95 to over $1000. The No. 515 shown above is rated for 1500 psig at 900°F and for 2000 psig at 600°F. It lists at $500. Armstrong prices are moderate for what you get because of high production. *There is no compromise made at the expense of safety, quality and low maintenance.*

Want more facts?—Call your local Armstrong Representative or write: Armstrong Machine Works, 368 Maple Street, Three Rivers, Michigan.

Do you have Catalog J?—This 44-page Steam Trap Book is free on request.

LIST OF MATERIALS
ARMSTRONG FORGED STEEL TRAPS

Part	Material
CAP AND BODY FORGINGS	
Up to 600 psi, 750°	1030 carbon steel
Up to 900 psi, 900°	ASTM Spec. F-1 carbon moly steel
Up to 2500 psi, above 900°	ASTM Spec F-5 chrome moly steel
VALVE AND SEAT	Type 440 chrome steel, heat treated, standard. Stellite available.
LEVER MECHANISM	Stainless steel
BUCKET	Stainless steel
BOLTS	Class C high tensile, high temperature bolting material – 125,000 min. tensile.
NUTS	Hex, semi-finish, heat treated for high pressure, high temperature service.
GASKET	Compressed graphited asbestos
INLET TUBE	Wrought iron

STEAM TRAPS FOR EVERY REQUIREMENT — APPLICATION ENGINEERED

ARMSTRONG STEAM TRAPS

Now They're Blueprinting Industrial Hygiene

"The best time to apply engineering control features to potential health hazards and factors in the working environment is at the design stage"

by J. W. Hammond

THE objectives of industrial hygiene are the prevention of disease and loss of efficiency through the control of occupational factors which may affect normal people.

In the past, industrial-hygiene practices were directed mainly toward the control of existing conditions. Today engineering control features are applied to potential health hazards at the design or blueprint stage, and a number of procedures have been developed for evaluating problems which are not apparent or cannot be controlled at the design or development stages.

Most of the occupational and health hazards found in the petroleum industry are not peculiar to it, and the experience gained in other industries can be applied directly in evaluating and solving its problems.

Objectives and scope . . . The objectives of industrial hygiene are to prevent disease and loss of human efficiency through the control of the occupational factors which may affect normal people. The scope of this science is to detect materials and physical agents within an environment which have health significance, to evaluate them in quantitative terms in relation to their effect on man, and to prescribe or design practical controls.

To accomplish this it is necessary to understand man's limitations, his occupational relation to his tools, his physical contact with materials in his work, and physical factors of the chemical and material atmospheric contaminants of his working environment. There is no material too toxic to be used safely and, conversely, there is no material so innocuous that it can be ignored.

Industrial-hygiene team . . . An industrial-hygiene team, to be fully reliant, is generally made up of the physician, the industrial-hygiene engineer, and the chemist. They must work closely with allied groups. Other speakers on this program have ably touched upon the important part of the physician.

Author is with Humble Oil & Refining Co., Houston. Paper presented at annual meeting, A.P.I., San Francisco, November 14, 1955, under the original title, "Industrial Hygiene in the Petroleum Industry."

TABLE 1—EXAMPLES OF INDUSTRIAL-HYGIENE SERVICES TO MAJOR DEPARTMENTS OF AN OIL COMPANY

Material—	Unit or process	Risk*
Refining—		
Lead	Painting	S
	Doctoring	M
	Welding	S
	Gasoline (TEL)	S
Mercury	Laboratory	M
	Meter shop	M
	Pilot plant	S
Benzene	Hydroformer	Sl
	Laboratory	M
	Dewaxing	S
Dust (silica)	Lubricating oil	M
	Reclamation	M
Dust clay	Contact treater	M
Carbon tetrachloride	Electrical	S
Production—		
Mercury	Meter	M
	Geological	S
	Gas testing	M
Lead	Painting	M
Insecticides	Camp site	M
Benzene	Paraffin removal	M
Carbon tetrachloride	Core analyses	S
Herbicides	Field maintenance	M
Noise	Drilling	M
Solvents (petroleum)	Drilling	M
Pipeline—		
Hydrogen sulfide	Pump station	M
	Gaging	S
Carbon monoxide	Pump station	M
Solvent vapors	Pump station	M
Degreasing solvents	Maintenance	M
Bitumastic coating	Pipe doping	M
Exploration—		
Carbon tetrachloride	Core analyses	S
Mercury	Core analyses	S
Benzene	Cable shop	S
Fluorinated plastics	Electrical	M
Law—		
Crude oil	Claim	Sl
Industrial waste	Claim	Sl
Air pollution	Claim	M
Research and development—		
Mercury	Reservoir lab	S
Carbon disulfide	Laboratory	S
Nickel carbonyl	Catalyst	S
Radiation agents	Reagents	M
Sales—		
Cutting oils	Customer shops	M
Solvents	Customer shops	M
Lead oxide	Paint plant	S

*S—Severe, M—Moderate, Sl—Slight.

The industrial-hygiene engineer is concerned primarily with field studies, collection of atmospheric samples, making of physical measurements, and evaluation of results in terms of effect on health and in the preparation of proposed control measures.

The chemist is concerned with analytical work involved in handling samples, as well as assisting in the collection of them. Frequently he serves by supplying information relative to the toxicity of products or materials and the interpretation of the field results.

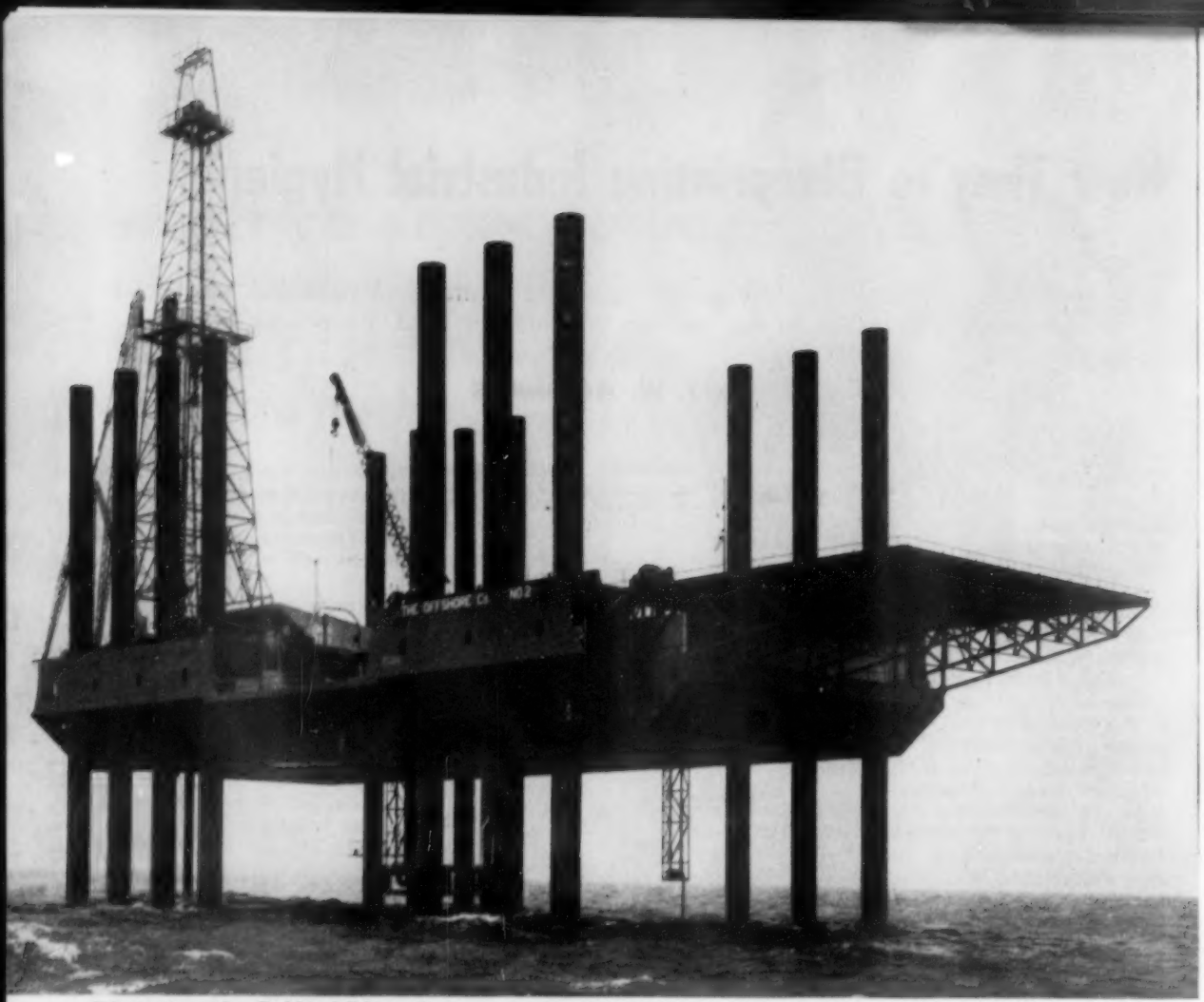
Industrial-hygiene practices . . . Past industrial-hygiene practices have been directed mainly toward the control of the existing working environment where processes, units, and operations were well established. It has been necessary to play "catch-up," and this has often made it difficult and costly to provide effective control facilities.

Today industrial hygiene has advanced to the point where it is realized that problems of environmental health will continue to increase as the catch-up approach alone is used. The best time to apply engineering control features to potential health hazards and factors in the working environment is at the design and blueprint stage.

A good illustration occurred in a new gas plant. In the laboratory it was necessary to use mercury in the distillation units. Spilled mercury found its way behind a laboratory bench and into minute cracks in the floor surface. From these places, its vapor rose to contaminate the atmosphere during the heating season while windows and doors were closed. It was necessary to replace the flooring with impervious material, and to relocate the furniture to allow cleaning behind each piece, to correct this moderately serious health hazard.

Admittedly, it will always be necessary for industrial-hygiene personnel to spend a good portion of their time studying existing environmental conditions and to evaluate them in terms of quantitative facts. The fact cannot be overemphasized that there are many obvious advantages to the application of industrial-hygiene principles at the design stage.

For example, control features are more acceptable and economical, and control features built into the process



Biggest on the Gulf is Offshore Company's multi-million dollar mobile platform capable of drilling in water depths of 100 feet to explore for the rich oil and gas reserves of the Miocene Trend miles below the ocean floor.

The Big Wildcatters Are Choosy

Where they're playing for million-dollar stakes, oilmen count on Pittsburgh Steel Company's seamless oil country goods to help lower the odds.

Offshore Company's $3.8 million mobile platform No. 2 is the largest entry in the sweepstakes for the rich oil and gas reserves below the ocean floor in the Gulf.

This ocean-going monster weighs as much as a tanker and has deck dimensions slightly smaller than a football field. It carries a 146-foot high drilling rig on its back, is generously equipped for fast drilling, and has first-class crew quarters.

When it moves into position, its fourteen sea legs are lowered and air-jack driven into the ocean floor. Each is a 6-foot diameter steel caisson, 200 feet long and weighing 100 tons. Then the barge climbs up the caissons until it is at a safe operating level above water, and begins drilling.

Once on location its towering framework can be battered by hurricane winds and lashed by waves. Yet it won't budge. Its powerful drilling equipment is built to stab through miles of earth beneath the ocean to reach pay quickly.

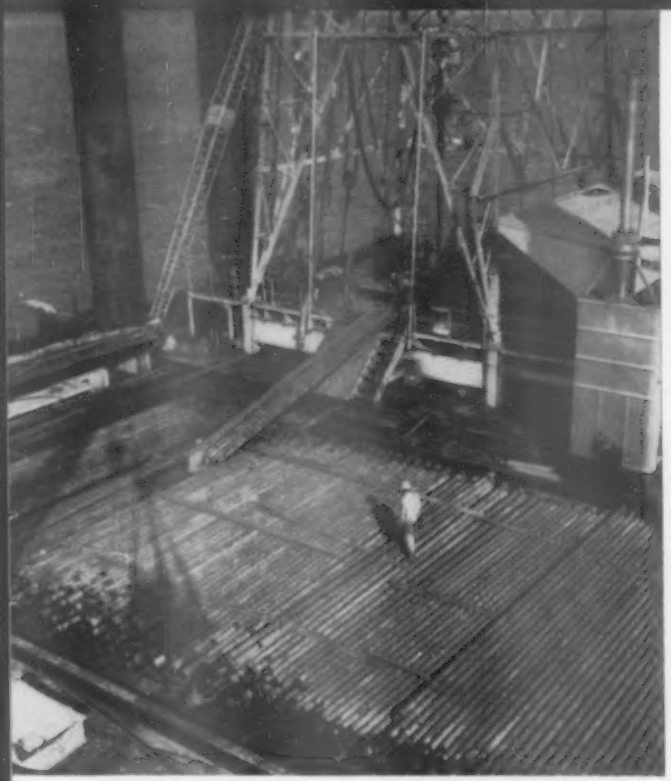
When you consider the large investment and heavy costs involved, you can understand why oilmen who operate equipment such as this can't afford to take chances on equipment or service.

The pay-off comes on the footage of hole drilled. All time and expense that does not deepen the hole, lowers profits. Equipment failures or service delays pile up losses rapidly.

The fact that this rig is equipped with Pittsburgh Steel Company's seamless drill pipe is a credit to the quality of the product. To oilmen who have relied on Pittsburgh seamless for more than a half-century, its selection is not surprising.

Offshore No. 2 is using 5-inch OD Grade E Range 2 drill pipe. It has a minimum yield strength of 75,000 psi, and needs every pound of it.

Rotating at 120 rpm and drilling an average of 500 feet of hole a day, as it was on the operation shown



Seamless drill pipe from Pittsburgh Steel Company, racked on the barge deck, is fed length by length into the hole as it deepens in the race to reach pay.

High above the ocean a derrick man stabs a stand (three 30-foot lengths) of drill pipe into the hole. This pipe goes in at better than a stand a minute.

here, the drill pipe at the top of the hole may be under a tension of well over 100 tons. It is subject to continuous fatigue and torsion. Abrasive and corrosive wear also are always present.

Pittsburgh seamless, along with other equipment for Offshore No. 2 was supplied through one of the independent distributors listed at right. The selection of an independent to provide the fast and flexible service needed for a rig such as this was natural.

As the barge reached its finishing stages prior to launching, the independent's field representative stood by on 24-hour alert. The mobile telephone in his car was busy with calls to his warehouse for instant delivery of required parts.

Now he calls regularly at the dock from which the rig is serviced, continuing his 24-hour, 7-day a week vigil to cut any costly delay that might occur. He provides the same experienced, personal service—free from red tape, cluttering paperwork, and remote control—that is the specialty of all independents on the list.

The next time you need a string of drill pipe, casing, or tubing, why not get the pipe of your choice through the supplier of your choice? Specify Pittsburgh seamless!

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Franklin Supply Company
624 South Michigan Avenue
Chicago 5, Illinois

Houston Oil Field Material Co.
1524 Maury Street
Houston, Texas

Industrial Supply Company
500 Eighth Street
Wichita Falls, Texas

Iverson Supply Company
400 West Fifth Street
Tulsa, Oklahoma

Lucey Export Corporation
233 Broadway
New York 7, New York

Lucey Products Corporation
624 South Cheyenne
Tulsa 19, Oklahoma

McJunkin Corporation
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Charleston 22, West Virginia

Midland Supply Company
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Washington St. Station
Wichita 7, Kansas

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Norvell Wilder Supply Company
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706 Commercial Standard Bldg.
Fort Worth 2, Texas

Rodman Supply Company
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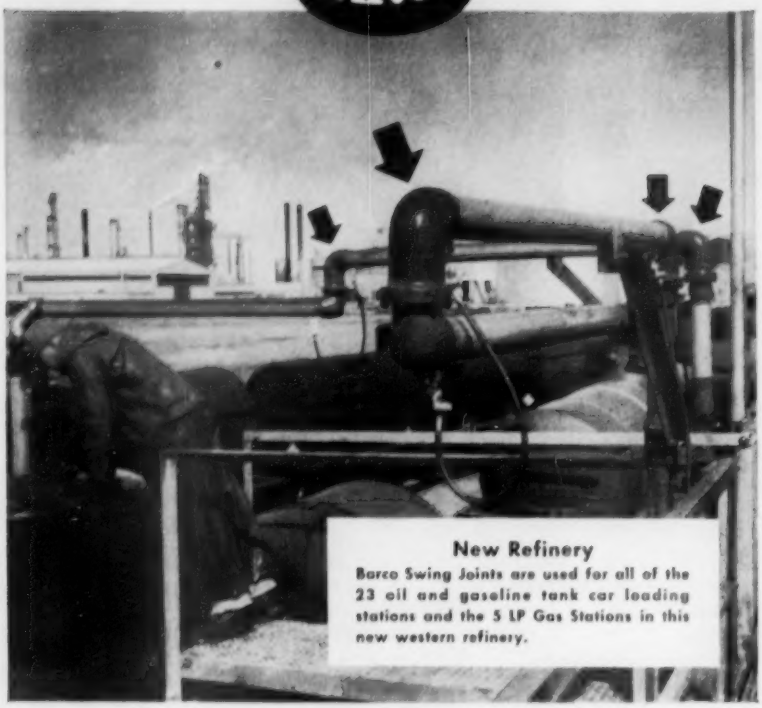
SWING JOINTS BARCO ASSEMBLIES



New Refinery

Barco Swing Joints are used for all of the 23 oil and gasoline tank car loading stations and the 5 LP Gas Stations in this new western refinery.

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1. **Controlled Torque**—Here is a feature users unanimously applaud in Barco's new Swing Joints—*no annoying, uncontrolled free swinging of lines.* They swing easily but stay put.
2. **Ball Bearing and O-Ring Equipped**—Designed specifically for handling gasoline, oil, lube oil, LP gas, and other fluids, including many chemicals, *without leakage.*
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6. **Custom Designed Installations**—Your Barco Representative will be glad to show you actual models of smooth-working, balanced assemblies and a wide choice of Barco custom designs. Choice of materials, including all-steel. Sizes 1", 1½", 2", 2½", 3", 4", 6", and 10"—eleven different styles of joints. Ask for Catalog 400.

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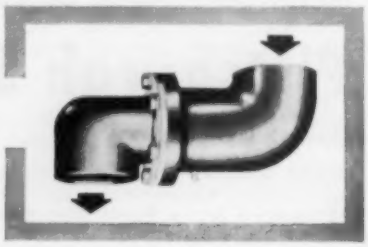

are more efficient, than those added at a later date. Furthermore, when the control measures are part of the original unit, no health hazard is permitted to exist even for a short period or until it could cause harm.

One finds that design engineers usually welcome constructive comments on anticipated health problems and control methods. It may be necessary for the industrial hygienist to establish channels for receiving plans for review, and it is necessary to stress the reasons for wanting them. It should always be made clear that the hygienist is in no way in competition with the design and development engineers but wishes to serve as a consultant staff member in a specialized phase.

Usually the information which he may supply to the engineering group is: (1) how toxic the materials in question are; (2) whether it is a problem of inhalation or skin contact; (3) what the possible points of exposure are; (4) how serious the exposure would be; and (5) what would be the best and most economical control methods.

Unfortunately, all problems cannot be controlled at the design stage. Obviously, some problems will not be apparent; but, if proper consideration is given to materials and processes to be used, potential health hazards can be predicted. For evaluation of new potential problems, as well as old ones, the following steps serve to point out the procedures commonly followed by the industrial hygienist:

1. Develop toxicity data on all materials used.
2. Determine quantitatively the atmospheric concentration of toxic materials.
3. Then, evaluate the health hazard based on recognized limits or standards, commonly called maximum allowable concentrations.
4. Place exposed workers under proper surveillance.
5. Develop, if needed, engineering methods of control.

The evaluation of the environmental health of a plant may be accomplished in the following order:

1. Make a preliminary survey, which is an inventory of the health factors, and a list of all materials used.
2. Whenever toxicological information so indicates, make atmospheric tests.
3. Determine atmospheric contaminants and physical factors of the environment in quantitative values.
4. Analyze biological samples (body fluids) where indicated.
5. Make statistical studies of sickness records.
6. Occasionally, develop toxicological data and apply them to the other factors in the survey.

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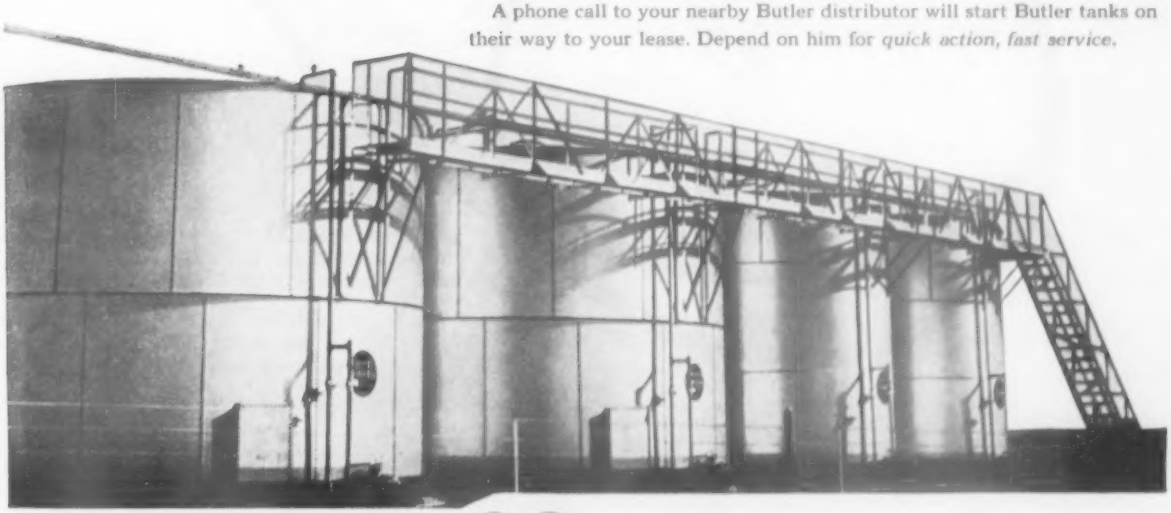
Your wells start earning revenue for you *right now*, when you call your nearby Butler distributor for fast erection of bolted steel tanks. His experienced sales and service team, and stockpiles of tanks near all major oil fields, are your guarantee of *quick action, fast service.*

Butler bolted steel tanks are made of die-formed, precision-punched sheets that go up fast, require little maintenance, stay in excellent condition for years. Choice of two-coat aluminum painted or hot-dip galvanized finish. Capacities 100 to 10,000 barrels.

A phone call to your nearby Butler distributor will start Butler tanks on their way to your lease. Depend on him for *quick action, fast service.*



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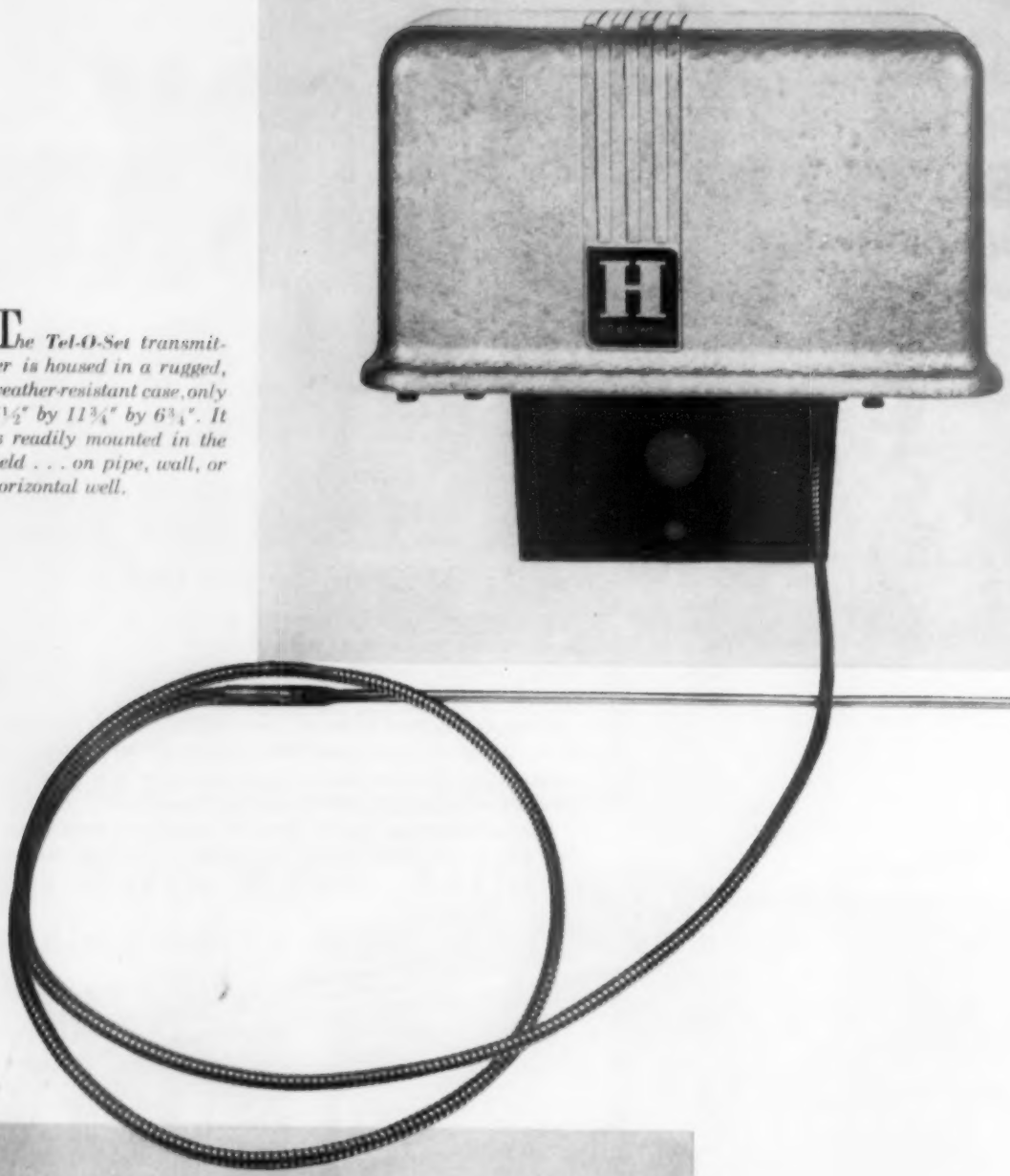
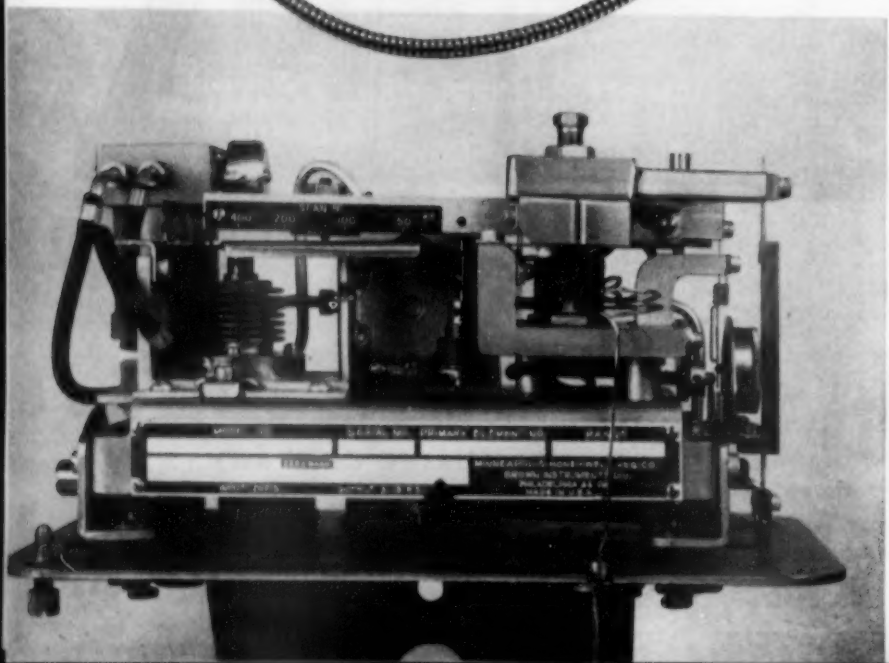
Factories located at Kansas City, Mo. • Galesburg, Ill. • Richmond, Calif. • Birmingham, Ala. • Houston, Texas • Minneapolis, Minn.

The Tel-O-Set transmitter is housed in a rugged, weather-resistant case, only 6½" by 11¾" by 6¾". It is readily mounted in the field . . . on pipe, wall, or horizontal well.





Interior view of the transmitter with cover removed shows the simple, sturdy force-balance mechanism. Span and zero adjustments are easily accessible . . . require no changes of parts.

Compare it!

The same *Tel-O-Set* Transmitter can be used for temperature, absolute pressure or gage pressure–in all ranges

Changeover is simple...takes little time and labor. And, there's no need to stock an assortment of thermal systems or spring assemblies.

Tops in performance, too . . .

In accuracy • In speed of response • In ambient temperature and pressure compensation • In resistance to vibration • In durability • In ease of adjustment and calibration • In operating economy

Span can be adjusted to any values between 20 psi or 50 F minimum, and 150 psi or 400 F maximum. Without changing parts, the span can be shifted to cover any part of the overall transmitter range . . . from –375 to + 1000 F, or from 40 to 550 psi.

This multi-purpose instrument will simplify the training of your operating and maintenance men . . . reduce spare parts inventory. And a single instrument does double duty as a standby replacement for either temperature or pressure applications. Its sturdy, corrosion resistant mechanism assures long service life.

Your local Honeywell sales engineer will be glad to discuss how the *Tel-O-Set* transmitter . . . and related *Tel-O-Set* miniature indicators, recorders and controllers . . . can work for you. Call him today . . . he's as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, Wayne and Windrim Avenues, Philadelphia 44, Pa.—in Canada, Toronto 17, Ontario.

● REFERENCE DATA: Write for Bulletin 7280, "*Tel-O-Set* Transmitters."

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Honeywell
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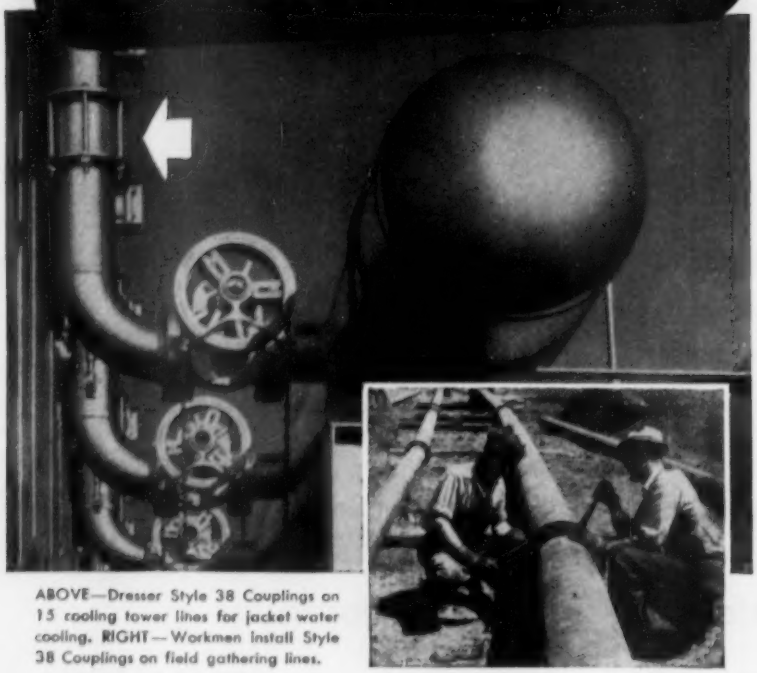
First in Controls

around a cooling tower...
the DRESSER way
is easier...surer!



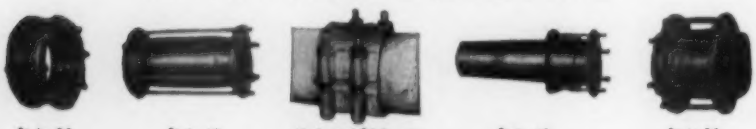
ABOVE—Dresser Style 38 Couplings on 15 cooling tower lines for jacket water cooling. RIGHT—Workmen install Style 38 Couplings on field gathering lines.

Anywhere you're joining pipe, the handiest, surest way to get bottle-tight joints is with Dresser Couplings or Long Sleeves.

Dresser Couplings provide the "give and take" necessary to absorb vibration, settlement and other stresses. Specially compounded rubber gaskets permit up to 4° deflection at joints—yet with Dresser Couplings, these joints stay permanently tight.

The only tool you need is a wrench—no pipe threading is necessary. Any workman can install Dresser Couplings, averaging only two man-minutes per bolt.

AVAILABLE AT LEADING OILFIELD SUPPLY STORES



Style 38 Coupling | Style 40 Long Sleeve | Hydrepair*Asbestos Cement Pipe Clamp | Style 63 Expansion Joint | Style 39 Insulating Coupling

*HYDREPAIR is a trade-mark of Dresser Manufacturing Division

DRESSER®

Dresser Manufacturing Division, 49 Fisher Ave., Bradford, Pa. (One of the Dresser Industries).
Warehouses: 1121 Rothwell St., Houston, Texas; 101 S. Airport Blvd., S. San Francisco, Calif.

7. Carefully study possible correlation between environmental and medical data.

8. Develop control procedures whenever indicated.

This same technique may be applied to handle most industrial environmental health problems. The data, whether negative or positive relative to health, provide a definite basis for management decisions on the need for control.

The experience of a unit with a regular painter points out the need for definite data. Surveys of materials used and methods of application showed no exposure to lead. However, the urinary lead indicated hazardous absorption. Inspection of the worker's off-duty activities disclosed that his exposure came from his home paint shop, where he painted farm machinery with red lead for his neighbors. He stopped that exposure and was soon normal in lead excretion.

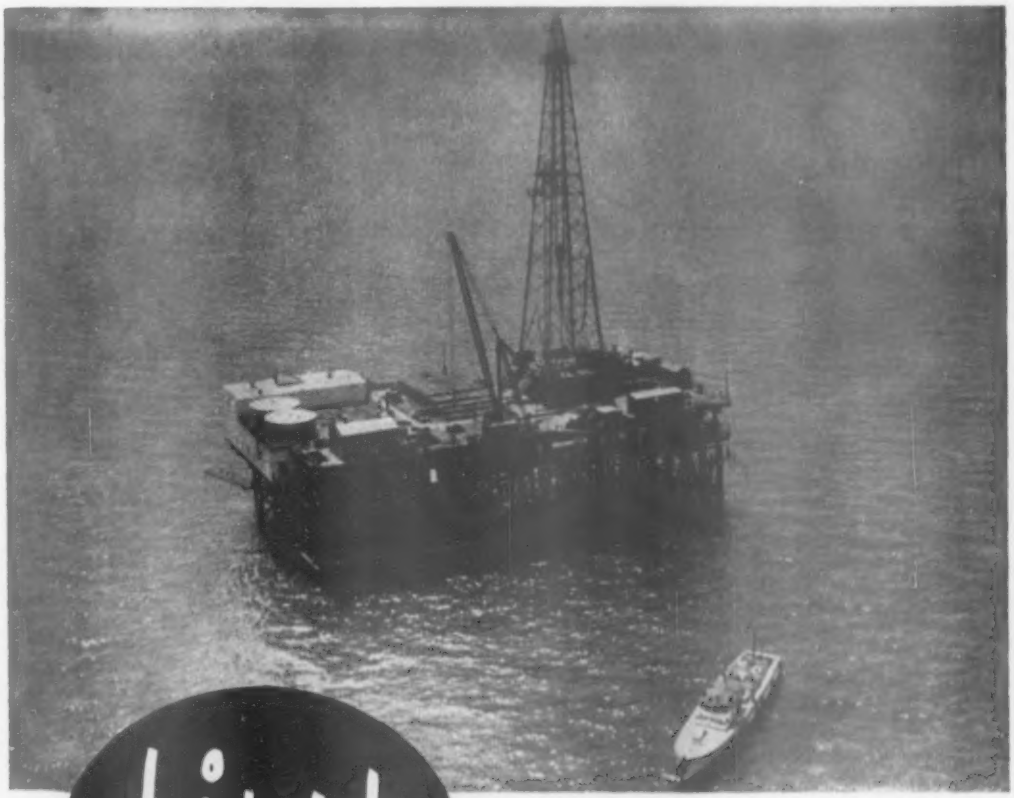
Extent of problems . . . It is of interest that most problems found in the petroleum industry are not peculiar to it. Materials and occupational health hazards recognized in machine shops and maintenance work, and in chemical, metal, electronic, and other industries throughout the nation, cause the same problems.

This is good news, inasmuch as the application of industrial hygiene is relatively new in the petroleum industry, and experience gained in other industries can be directly applied in the evaluation and solution of its problems. A few representative examples of industrial-hygiene services to major departments of an oil company are listed in Table 1.

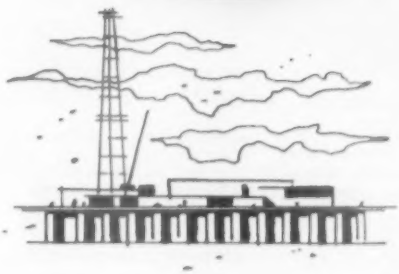
Benefits . . . Union and labor interests in fields of health and fringe benefits necessitate good liaison with official agencies. These agencies are state departments of health and labor, compensation boards, and other regulatory groups. One must be prepared to compare data for work areas in plants with their data.

We often find it possible to be of service to the sales department in preparing precautionary labels as to safe use of petroleum products. Other fields of service may be to customers concerning the safe use of petroleum products in their plants.

This field is not static. It is dynamic; and, therefore, it is necessary to keep in contact with others in this field by participation in professional activities. Industrial-hygiene activities extend the medical services out of the clinic into the industrial plant. They provide a mutual contact between the engineering and maintenance group in the field and the physician.



first OFFSHORE STRUCTURE AND STILL best



The FIRST all steel offshore drilling platform in the Gulf of Mexico was designed and built by the W. Horace Williams Co., Inc., off Grand Isle, Louisiana, in 1947—and is the LARGEST platform in the Gulf.

Over 30 other platforms have been designed and built by the W. Horace Williams Co., Inc., and designs are now completed for **water depths up to 200 feet.**

For the best in engineering and construction contact

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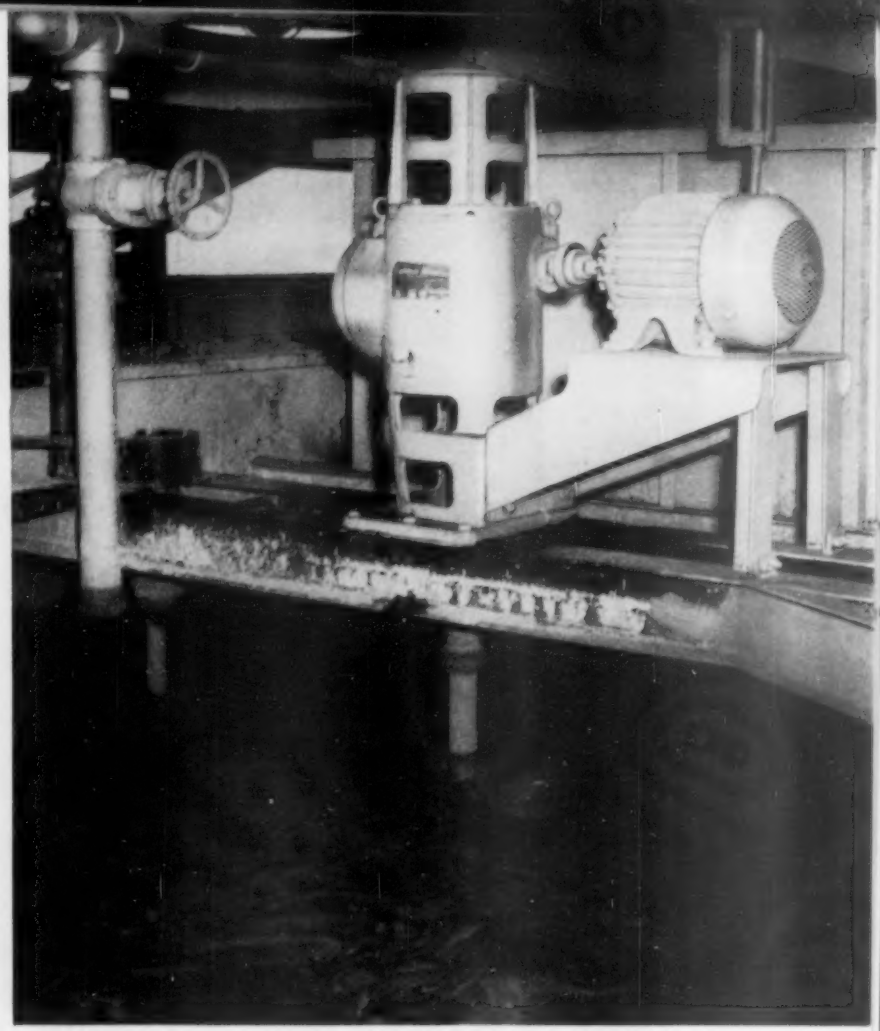
Marine Contractors Since 1908

NEW ORLEANS

OFFSHORE STRUCTURES, WHARVES, BULKHEADS, FOUNDATIONS

Why the mud's **always good** *off the Gulf Coast*



There's a powerful difference between ordinary drilling mud and this mud you're looking at, in the tank of an LST drilling barge off Galveston Bay.

This mud has waves in it.

And under the waves, where it counts, this mud flows and interchanges constantly. A strong, steady flow sweeps every corner of the tank—keeping *all* the mud equalized, *all* of it ready for immediate use down the hole.

Mud can't settle out; so less mud is used. The mud bill is much lower than when mud is mixed the old way.

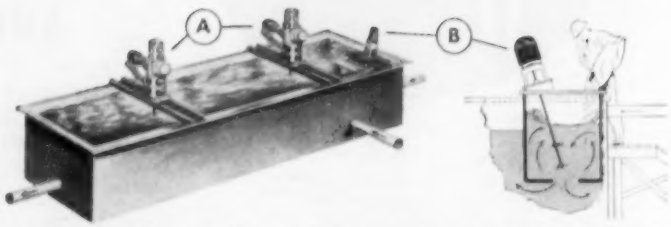
Heavier or thicker mud—in seconds—Every gallon of mud in this system is the same weight and viscosity. And you can *change* mud weight and viscosity, as much or as little as you want, literally *in seconds.*

In an emergency, you can feed-in weight and gel additions by the whole sackful—one sackful right after another. There's no clogging, no waiting. *Immediately,* the whole system shows a uniform weight rise. Within a few minutes, weight and viscosity are completely equalized.

You get this always-flowing, top-condition mud with LIGHTNIN Mixers. First, a high-speed LIGHTNIN Flash Mixer wets and feeds ingredients to the flowing mud—as fast as you can dump them in. Meanwhile, the big LIGHTNIN Mud Mixer you see here distributes the materials evenly—keeps mud fluid and ready to go to work.

Make savings like these—You actually *save* on power, because you need not use a standby pump for tank circulation. The LIGHTNINs do the work, on about *one-tenth* of the usual pump horsepower.

You cut maintenance cost, too. There are no pump parts, valves, or fittings being chewed up in mud agitation service. The only parts that touch mud are the LIGHTNIN Mixer shaft and impeller—easily replaced at any time, for as little as *one-third* your present upkeep cost.



KEEP MUD IN TOP SHAPE with this simple system. One or two LIGHTNIN Mud Mixers (A) have rotating turbines that keep mud flowing, equalize it quickly. Mud weight and viscosity change almost instantly when weight and gel ingredients are added through LIGHTNIN Flash Mixer (B) in open-bottom well.

These are some of the reasons why LIGHTNIN mud control is fast becoming "standard" on offshore drilling barges. Independent drilling men and oil companies are getting better mud—for less money—with LIGHTNINs in many land tanks and earthen pits, too.

Doesn't this make you feel that LIGHTNINs for *your* mud mixing are worth a closer look? Here's how to get the facts, firsthand. Ask your LIGHTNIN sales engineer to arrange a field trip to a barge or land rig in your area so you can see LIGHTNINs at work.

You'll find his name listed in Composite Catalog—or just write, wire, or phone us direct.

SEND FOR this free 6-minute picture story. It shows how you get instant mud control and cut costs, too, with LIGHTNIN Mud Mixers.

MIXING EQUIPMENT Co., Inc., 174-m Mt. Read Blvd., Rochester 11, N. Y.
In Canada: Greey Mixing Equipment, Ltd., 100 Miranda Ave., Toronto 10, Ont.

"Lightnin" Mixers

Thirty Years of A.P.I. Standards

Simplification, interchangeability, and quality control—these words sum up the accomplishments of one of industry's most effective cooperative efforts

by John R. Suman

ORDERLY operations, where previously only chaos prevailed, are in part a direct result of A.P.I. standardization. Type standardization and interchangeability of the product of different manufacturers brought about an industry economy that has been and will continue to be beneficial to all having an interest in the oil business.

A.P.I. standards are international in scope, and the work of the standardization committees in keeping abreast of advancements in oil-field operations continues to be dynamic.

The need of cooperation between the standardization agencies that are concerned with international standards on oil-field equipment, for the purpose of promoting the use of approved international standards, is urgent in the interest of the successful development of oil properties throughout the world.

Supply needed . . . The very nature of the operations as they occur in the oil fields is such that there must be a ready supply of expendable material and parts conveniently located to the site of operations so that in an emergency this equipment will be available for use at short notice and thus prevent costly delays.

When this equipment was of a size and fit that were peculiar to the individual make only, large inventories and stocks had to be maintained so that when a part failed or needed to be replaced, the right part would be available for use.

Even with such large inventories, it was by no means uncommon not to be able to find the right part at the right time, and operations frequently had to be shut down for days at a time waiting on the buyer and supplier getting together and eventually furnishing the needed part or making some makeshift repair while crews waited and costs mounted.

This lack of standardization and coordination, and possibly the urge for business brought about by competition, resulted in the use of a multiplicity of sizes which greatly added to the confusion and burdensome cost of operation. The cable-tool method of drilling was more widely used than the rotary method in those days, and typical of the conditions as they existed at that time was the more than 300 different sizes of cable-tool joints and over 200 different sizes of rotary taper joints.

Oil-country tubular goods, which comprised casing, tubing, drill pipe, and line pipe, were being finished with threads and couplings that would not permit the product of one manufacturer to be interchanged with the product of another manufacturer. This same condition existed in the case of sucker rods, oil-well pumps, derricks, production storage tanks, and other equipment.

In the face of what appeared to many to be an insurmountable task, the A.P.I. through its board of directors authorized in 1923 the appointment of committees consisting of user and manufacturer representatives to develop standards and specifications on various items of oil-field equipment, and in 1924 created the Division of Standardization to administer the work of these committees. The scope of the work was: (1) simplification of sizes; (2) interchangeability between mating parts; (3) specifications to control the quality and grade of material; and (4) maintenance of interchangeability between products of different manufacturers by means of gages and a gaging practice.

Simplification . . . Concerning the matter of simplification of sizes, the efforts of the A.P.I. standardization committees resulted in the industry's use of only 14 sizes of cable-tool joints, whereas previously there were more than 300 sizes being used. The number of different derrick heights and base sizes in use prior to A.P.I. standardization was more than 200, and this number was reduced to only six sizes. There are only 16 sizes of rotary taper joints in use today which may be compared to the several hundred different sizes in use before standardization.

After the Committee on the Standardization of Oil-Country Tubular Goods had been active in preparing specifications to control the size and quality of tubular material, a further effort was made to simplify casing sizes. At that time there were 195 items of seamless and electric-weld casing in sizes 4½ in. to 13⅜ in. o.d., inclusive; and this list was reduced to 75 items, or only 38.5 per cent of the original number.

In the new list the sizes were extended downward to better provide for slim-hole drilling, and the strength of casing was extended upward to take care of deep drilling. These are but typical examples of the accomplishments of size simplification as a result of the A.P.I. standardization program.

Interchangeability of Product

Interchangeability of mating parts and of the product of one manufacturer with the product of another manufacturer is an accomplishment for which the A.P.I. can rightfully be proud. The American petroleum industry is the only industry that has made interchangeability between the products of competitive manufacturers a practical accomplishment, not only throughout the United States of America but in foreign countries where oil is being produced.

When one looks back to the time when it was impracticable to mix different makes of pipe in a casing string and considers the manifold problems that resulted from this state of affairs, we can fully appreciate the importance of product interchangeability.

The use of certified master gages made within specified limits or tolerances was the key to maintaining interchangeability of the products of different manufacturers. A system was established by the Division of Standardization whereby every manufacturer desiring to comply with A.P.I. standards was required to supply himself with the necessary reference master gages which were certified as to their accuracy by the National Bureau of Standards. This system was later expanded to cover all threaded connections, including rotary-tool joints, cable-tool joints, sucker rods, etc.

Quality control . . . Specifications controlling the quality and grade of material for the major items of oil-field equipment have been prepared by the various committees and cover oil-country tubular goods, derricks and portable masts, valves and wellhead fittings, wire

Author is consultant, Houston. Paper presented at annual meeting, A.P.I., San Francisco, November 15, 1955, under the original title, "The Past and Future of A.P.I. Standards on Oil-Industry Equipment."

First offshore use New Electro Drilling Rig

Phillips Petroleum Company's rig, working in the Gulf off the Louisiana shore, is the first offshore application of the new Electro-Motive Drilling Rig Power Plant.

The 1,750-horsepower system, comprising two 8-cylinder, 875-h.p. Diesel-Electric generating units, is being used on a self-contained platform, with the General Motors units conveniently housed on the drilling platform.

Saves high-cost platform space

The Electro-Motive units enable Phillips to save several hundred square feet of high-cost platform space that would have been necessary with a Diesel-mechanical rig. The Diesel-Electric generating units eliminated the need for alignment with draw works, rotary table or mud pumps which would have been required in a mechanical-type rig.

Flexible electric cable from the basic generating units are connected to seven Electro-Motive motors which supply power for the rotary table, draw works and two mud pumps. The draw works is a steam type with a jaw clutch now powered by two Electro-Motive 625-h.p. direct current motors.

Quick setups—easy connections

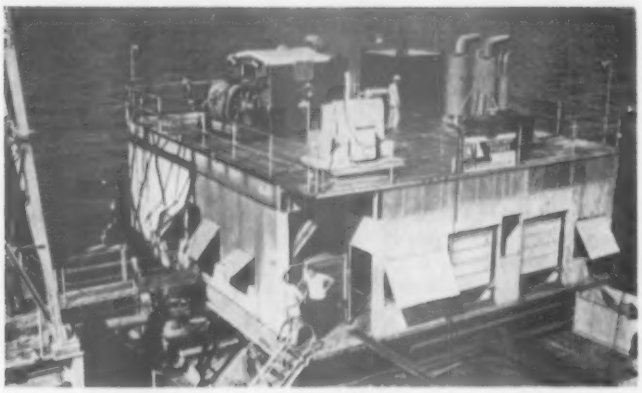
These units are identical with the two 8-cylinder Electro-Motive engine-generator sets used earlier this year on a land rig of the Offshore Company near Houma, La., and now drilling a second well in Louisiana. *In a test on this rig, simulating engine failure, cables were completely reconnected in only seven minutes.*

These flexible units offer the petroleum industry an entirely new concept in a Diesel-Electric drilling rig—the smoothness of steam with none of its disadvantages. A compact, lightweight package with all components engineered, built and backed by *one* manufacturer, the Electro-Motive system features simplified control and rugged dependability at a cost far below that of previously built Diesel-Electric rigs and comparing favorably with Diesel-mechanical rigs.

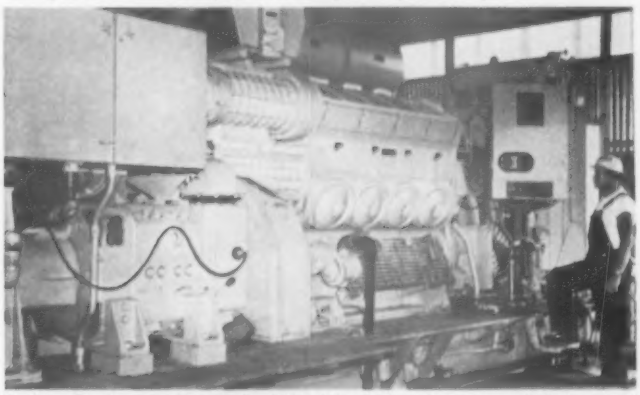
For further information, write or call your nearest Electro-Motive representative. Electro-Motive Division offices located in: New York City, Chicago, Jacksonville, St. Louis, Tulsa and San Francisco.

of
-Motive
Power Plant

Phillips Petroleum Company rig making hole 35 miles out in the Gulf of Mexico—with 1,750-h.p. Electro-Motive system



Power for Phillips Petroleum Company rig 35 miles out in Gulf of Mexico is supplied by 1,750-h.p. Electro-Motive Diesel-Electric generating system housed in building at right. Two 8-cylinder 875-h.p. units supply power for seven electric motors to run draw works, rotary table and mud pumps, saving several hundred square feet of high-cost platform space.



Eight-cylinder, 875-h.p. Series 567C Diesel-Electric power unit is inspected by tool pusher, M. J. Johnson. Extremely compact and light in weight, these rugged units are individually skid-mounted for easy, fast setups and economical moves. Old-timers in the oil fields have expressed surprise at the engine's quick starting, one of the unique features of its time-proved two-cycle design.

Driller C. Reeves of Franklin, La., at controls of the big Phillips Petroleum Company rig. The new plant brings to oil-well drilling the long-sought advantages of extremely high torque at extremely low speeds. The Electro-Motive system provides instantaneous control and it is offered at a price hitherto untouched by other equipment of this type.

Features of Electro-Motive Drilling Rig Power

Completely Integrated Design—Each of the major components designed and built to work together—*one* manufacturer—*one* source of service responsibility.

Maximum Portability—All components on skids, with weight reduced to a minimum. Units are ruggedly designed to withstand moves. No position problem—slashes setup time.

Unmatched Flexibility—Transmission of power is by cables. Slip connections on all cables and controls are so simple anyone can handle them.

Simplified Control—Centralized position for all controls for driller's convenience. Continuously variable draw works speed control without gearshift or reconnection.

Lower Drilling Costs—Lower first cost and lower cost per well drilled. Smooth electric power—flexible control—speeds drilling, means less down-time.

COMPLETE NATIONAL SERVICE AND PARTS AVAILABILITY

ELECTRO-MOTIVE DIVISION · GENERAL MOTORS

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World's Largest Builder of Heavy-Duty Diesel Engines and Electric Traction Equipment

rope, tanks, drilling equipment, and pumping equipment and engines. These specifications are international in their application and number 31 at the present time.

Changes in specifications . . . There have been many changes made in A.P.I. specifications since the early days of standardization to keep abreast of conditions and improvements in industry. With the increase in drilling depths and in the number of wells drilled, the work of standardization must of necessity increase proportionately and continue to be dynamic. The work of the Committee on Standardization of Tubular Goods can be cited as an example of the need to continually revise specifications.

At the time this committee issued its first specification on casing in 1924, Grade C material with a yield strength of 45,000 psi. was the strongest casing available and was adequate for the maximum well depths (3,500 ft.) then drilled.

It was not too many years later (1929) that a Grade D casing with a yield strength of 55,000 psi. was required; and as drilling depths continued to increase beyond 10,000 ft., a grade of casing with a yield strength of 80,000 psi. was needed and was adopted in the year 1938 as an A.P.I. standard. The committee has recently recommended the adoption of a Grade P-110 casing which will have a minimum yield strength of 110,000 psi. or which is two and a half times as strong as the strongest casing available when the casing specifications were first published.

Special Accomplishments

There have been some more or less recent outstanding accomplishments of the several standardization committees among which is the adoption of the round-form thread for casing and tubing. This type of thread has a rounded crest and root and proved to be a more practical thread for use on casing and tubing than the previously used American standard or Briggs thread.

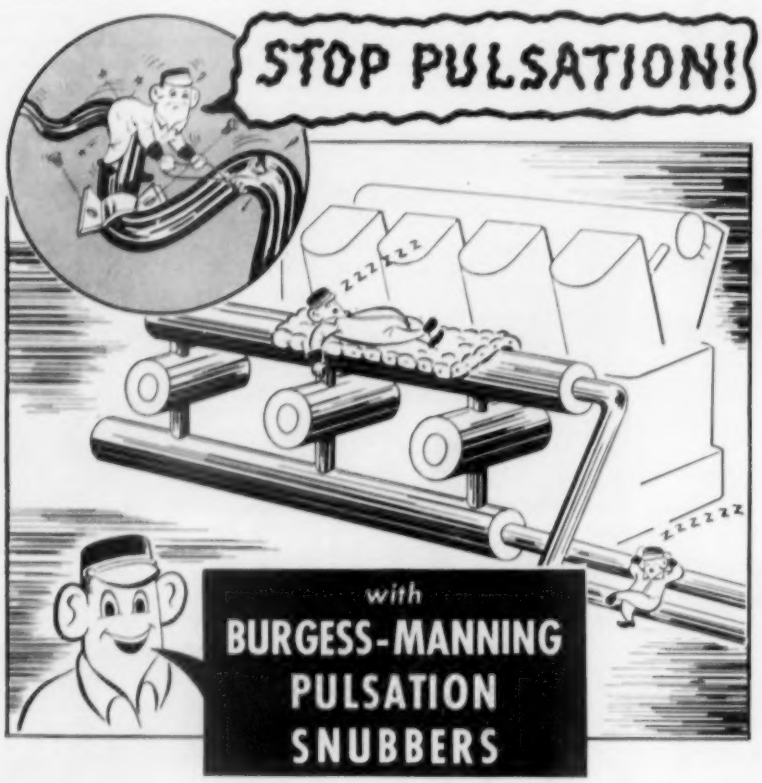
Other accomplishments worthy of particular mention are the type standardization of pumping-unit speed-reducer ratings, development of a method of rating portable masts, adoption of a complete series of ring-joint flanges, selection of casing items on the basis of its performance properties, and the establishing of minimum performance properties of A.P.I. casing and tubing.

As national chairman from 1929 until 1945 of the Committee on Standardization of Tubular Goods, I recall some of the lively and sometimes heated discussions that took place in our committee meetings in the interest of fitting the pipe specifications to the changing conditions and needs of the oil industry. Painstaking effort and thought were involved in establishing tolerance limits for pipe threads and the adoption of a different form of thread for casing and tubing.

The Pipe Committee pioneered the specification of tolerances for all product thread elements (A.P.I. Std. 5B), and thereby assured industry of a more satisfactory product than was previously available. Experience in the use of the round thread revealed such benefits that a saving in time of about 20 per cent was effected in running casing with this form of thread, and the joints were easier to stab and made up more uniformly.

The development of a full line of ring-joint flanges by a subcommittee of the Pipe Committee filled a most urgent need, and these standards are now a part of American Standard B16.5: Steel Pipe Flanges and Flanged Fittings. Before the dimensions of ring-joint flanges were established, it was not uncommon in the oil fields, when moving a drilling rig, to lose the ring of the ring-joint flanges then in use.

Because the dimensions of the ring



Burgess-Manning Pulsation Snubbers will remove one of your most aggravating and costly bug-a-boos, that of line surges from compressors, pumps, blowers, etc. Maintenance and service costs will drop sharply — lines and associated equipment will operate at a new efficiency — flow control can be greatly improved. Structural supports of pipe lines need no longer be of costly and special construction — gas compressors and pumps will deliver full design flow with greatest efficiency in pulse-free piping.

Send us your specifications for recommendations

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Sound Engineering

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and of the ring groove in the flanges were different in the case of the several makes of flanges, the men on the rig, not knowing the make of flange they were using and being unable to find a replacement ring at hand, would often wastefully throw away perfectly good flanges and in their place use a set of flanges of another make complete with ring.

Publication of the minimum performance properties of casing and tubing in A.P.I. Bul. 5C2 provided the information so vitally needed for the economic and safe use of deep-well casing and tubing strings. This information was the successful result of considerable testing of material and a careful study and analysis of the data on the part of those taking active part in the work of the Pipe Committee.

Standards in emergency . . . At the time the United States became involved in World War II as a belligerent country, a project was under way to establish National Emergency Steel Specifications. It speaks well of the caliber of the work of A.P.I. standardization to say that the Institute's specifications on oil-country tubular goods (Std. 5A) and line pipe (Std. 5L) were adopted by the Iron and Steel Division of the War Production Board with but minor changes, as the specifications to be used in administering steel priorities and allocations involving the manufacture and use of this type of tubular material.

Also, the Institute's specifications on production tanks were accepted by the United States Army without change during this period of emergency, and resulted in greatly simplifying procurement at a time when supply was most urgent.

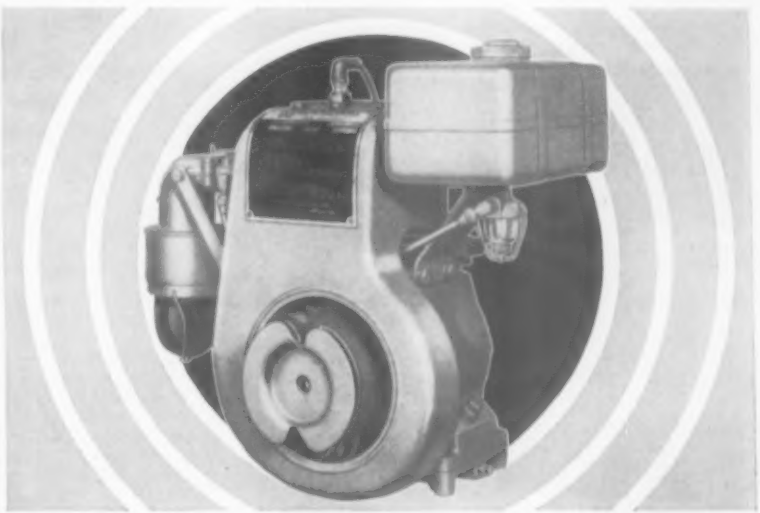
International standards . . . In the matter of international standardization, A.P.I. standards have been accepted by and are being used in practically every foreign country that is today producing oil. Attendance at meetings of A.P.I. standardization committee meetings includes representatives of many countries who feel it necessary by their presence to keep in touch with the deliberations and work of the committees. Also, there are many leading equipment manufacturers in foreign countries who have applied for and have been granted authority to apply the official monogram of the A.P.I. to their products, thus indicating full compliance with the Institute's specifications.

There are at present 575 manufacturers in the United States and 233 manufacturers located outside of the United States who have authority to use the A.P.I. monogram on their products. The dynamic nature of the program is again illustrated by the fact that the number of licensed manufacturers has increased by 154, or 24 per cent, since the first of the year.

By means of a system of gage calibration and certification as to gage accuracy by recognized official testing agencies in various foreign countries, it is now possible to successfully interchange equipment made to A.P.I. specifications but whose source of manufacture is in different countries.

The component parts of a rotary or cable-tool drilling rig purchased from manufacturers in 15 different countries can now be assembled at any well location in the world to drill satisfactorily to present maximum depths. Tools that are manufactured in Austria will fit perfectly with those made in England or the United States of America. Casing, tubing, drill pipe, or line pipe obtained from Germany will interchange with similar pipe made in Japan and give service comparable to that of pipe made at an individual pipe mill.

Savings . . . Monetary savings attributed



Another *NEW*
WISCONSIN Heavy-Duty
***Air-Cooled* ENGINE**
The Model BKN 3.2 to 6.8 H.P.

Brand new in design, this engine meets the increasing demand among original equipment manufacturers and engine power users for a compact, light weight, HEAVY-DUTY Air-Cooled Engine that offers a broad, flexible power range.

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to A.P.I. standardization cannot be accurately determined. Since the program was begun, however, many billions of dollars' worth of oil-field equipment has been manufactured to these A.P.I. standards. A figure of 10 per cent of the dollar value of material produced is now generally taken as the savings that accrue to standardization, and this figure will, it is believed, put the savings at between 50 and 100 million dollars annually.

Future

In looking away from past accomplishments in the field of A.P.I. standardization and toward the future, the problems with which the industry is confronted in having to drill ever deeper and offshore wells in the search for petroleum will require vigilance on the part of the A.P.I. standardization committees if they are to keep abreast of conditions. There is a trend to slim-hole drilling, to completing two or more wells in a single bore hole, and to the automatic operation and control of oil properties. Operations such as these appear to provide a fertile field for the standardization and simplification of the equipment needed.

Deep drilling, defined as the depth range of 15,000 to 20,000 ft., will require a grade of drill pipe that is better able to withstand the combined loads imposed on this item of equipment than the present highest grade of A.P.I. drill pipe. Also, casing programs may have to be changed if these depths are to be reached with a workable-size bore hole; and this, in all probability, will require changes in the A.P.I. list of casing sizes.

Abnormal pressures being encountered in many areas today are such that A.P.I. tubing is entirely inadequate although I understand a higher grade than Grade N-80 tubing has been recommended by the Pipe Committee for adoption, and consideration is being given to needed heavier weights of tubing. Wellhead equipment, including valves and fittings, is an item which must undergo a radical change if it is to safely handle well pressures in excess of 10,000 psi.

To continue using A.P.I. ring-joint flanges for this equipment at these higher pressures would require such enormous-size flanges and bolting as to make them impracticable. This problem is being solved by the use of pressure-energized seals.

The American Standards Association, Inc. (A.S.A.), is an organization which is devoted to obtaining national recognition of standards formulated by competent interests. As its object, A.S.A. serves as a clearing house for information on standardization work in the United States and foreign countries and furthers the standardization movement as a means of advancing national economy and promoting a knowledge of and the use of approved standards.

International in Scope

American Petroleum Institute standards, as previously mentioned, are international in their scope; and in the English-speaking countries, these standards have been adopted by several of the national standards agencies or have been used as the basis for the promulgation of related standards in which the interchangeability provision of A.P.I. standards has been preserved. The British Standards Institute, which is the counterpart in Great Britain to the American Standards Association, has a very complete and extensive program on the standardization of equipment for use in the oil fields and is following A.P.I. standards in almost every particular in its specifications.

In the international field, there is an international standardization agency which functions under the name of the International Organization for Standardization (I.S.O.) and which has before it several proposals including the development of standards for pipeline materials in oil-field operations.

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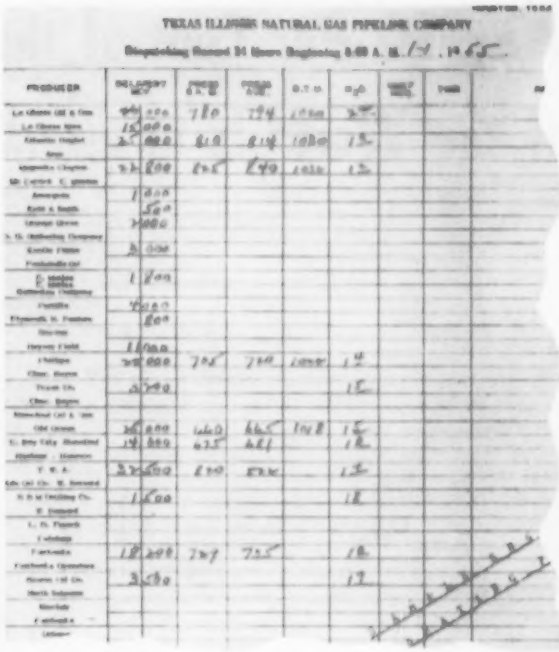

FACSIMILE TRANSMISSION EQUIPMENT was used to transmit and reproduce the above photo and data sheet. Material was sent over Texas Illinois Pipeline's microwave system between Chicago and Houston.

When teletype or voice won't work . . .

. . . Send It by Microwave

FACSIMILE transmission of maps, data sheets, and drawings can become the latest communication aid to pipeline operations. That the process is feasible was shown recently in test demonstrations over the private microwave system of Texas Illinois Natural Gas Pipeline Co.

Maps, drawings, photographs, and other matter which could not be sent as teletype or verbal messages were relayed by microwave. Excellent results were obtained using the 12-channel Motorola microwave system installed in 1952.

For the demonstration, facsimile transmitters and receivers were placed at Chicago, at Malvern, Ark., pipeline field operating headquarters, and at Houston, headquarters for gas production. To avoid disrupting any of the 12 microwave channels in regular use by Texas Illinois, a temporary "Channel 7½" was inserted between Channels 7 and 8. Multiplexing equipment from Motorola's new 24-channel microwave system was used for the insertion.

Sample logs, charts, and drawings that might be needed in daily pipeline work were transmitted during the tests. Also, pictures were taken and transmitted to show the physical setup and to demonstrate on-the-spot photo transmission. Prior to the tests, identical copies of the test material were sent to each reception point, making possible side-by-side comparisons of the original and recorded copy.

Possibilities for use . . . The tests show facsimile can be useful to oil and gas pipelines in many ways, among them the following:

1. Transmission of photos showing equipment failure.
2. Gathering of pay roll data.
3. Verifying signatures and documents.
4. Central office examination of compressor-engine performance cards.
5. Centralized bookkeeping and billing where speed is a factor.
6. Rapid transmission of aerial patrol photos.
7. Transmission of meter charts for central analysis of operating conditions.

How system works . . . The facsimile equipment used is made by Acme Telectronic Division of NEA Service, Inc. In the process, copy to be transmitted is wrapped on a rotating drum and scanned by an optical system. Light reflected from the copy varies with density of the marking and a phototube converts the light variations into a varying voltage. White parts of the copy give maximum output, while black gives minimum.

This direct current output then amplitude modulates a constant-frequency, 2,100 cycles per second oscillator.

On the reception the amplitude modulated audio tone is demodulated to yield varying voltages. These are converted to varying light intensities for recording on photographic paper or film, or to variable current for electrolytic etching on chemically treated facsimile paper.

A standard voice circuit is adequate for high definition recording. Thus, while microwave with its high channel capacity is ideal, a good-grade wire line may also be used with good results.

In the equipment tested copy is scanned at a drum speed of 100 r.p.m. with definition of 100 lines to the inch. So facsimile copying is at the rate of 1 in. per minute.

Why 90 Per Cent of the Oil Reserves of the World Is in Friendly Hands

The reasons are a tribute to international oil companies

by T. L. Lenzen

THE growth in production of foreign oil has profoundly influenced social, economic, and political institutions of the producing countries, both in Latin America and the Middle East; and the development of these foreign sources has added immeasurably to the military strength of the free world.

Most of the expansion of petroleum industry outside of North America has taken place over a relatively short span of time, a tremendous accomplishment of private enterprise. These private oil concerns have had to surmount a number of problems not ordinarily encountered by business enterprises. Most of these problems are of a continuing nature. As such, they continue to affect the progress of the foreign oil industry and influence—almost directly—our domestic industry and our national welfare and security as a whole.

A number of American oil companies play a key role in the foreign oil situation. They thus have a deep responsibility to conduct their affairs in a manner which will serve the greater interests of the American people. To assess the conduct of these companies and determine whether they are really serving America's best interests, it is essential to have a knowledge of the special problems encountered in the foreign oil field and how these problems have been and are being solved.

Background and Development

The early history of the petroleum industry overseas is probably familiar to all oil men. Development in the countries to the south of us came into its own in the period between the last two world wars, but the Middle East has been a much more recent addition to the world's production. It was really the pressure of allied military demand which initially dictated swift and broad development of the tremendous reserves that had been outlined in this area.

Paper presented at annual meeting, A.P.I., San Francisco, November 16, 1955, under the original title, "Responsibilities of International Oil Companies." Author is vice president, Standard Oil Co. of California, San Francisco.

At the conclusion of World War II, military demand was supplanted by the needs of a rebuilding Europe, and the expansion of the Middle East industry continued apace. As a result, the pattern of international oil flow today is markedly different from that in the prewar era.

This flow, formerly from west to east across the Atlantic, now is principally from the Middle East to Europe, supplemented by an additional south-to-north movement from the Caribbean countries. Almost 80 per cent of European oil requirements are now supplied from the Middle East and the remainder from the Caribbean and the United States. One need only point out that while the total world production has approximately doubled in the last 10 years, that of the Middle East has increased four times.

Problems encountered . . . The development of foreign oil to its present position involved and continues to involve the international oil companies in perplexities of social, economic, and political nature which have very little in common with ordinary operational problems.

In the initial stages of development, this was not always the case. Companies functioned on a businesslike basis; they made their bargains, risked their capital, and felt that the day-to-day welfare of the local populace was its own concern and perhaps that of the local government, just as is the case in western countries.

Relations between the company and the people quickly passed out of this stage, however, as it became apparent that some assistance would have to be given to improve the basic living and educational standards of the local employes.

Thus, while the company concentrated its prime interest on the oil industry, it did assume some responsibilities of providing housing, health services, schools, roads, and public utilities; and this was not always limited to local employes and their families. As the governments became aware of the force for social benefit which the companies could exert, they not only encouraged these activities, but some insisted upon it.

Arabian American Oil Co., or Aramco as it is commonly known, is a notable example of a firm which has engaged in such a relationship, even to the extent of lending to Saudi Arabia the funds for and supervising the construction of a 350-mile standard-gage railroad from the Persian Gulf to the interior capital, Riyadh.

Aramco has also built hospitals, which handle an average of a thousand out-patients daily, roads, schools, utilities, and modern housing and recreational facilities for employes, as well as forwarding agricultural, water-conservation, and public-health programs.

Those companies which must continue to provide social welfare facilities recognize that this is a function far removed from the ordinary sphere of business activity. Yet they do this job, however costly and time-consuming it may be.

It has been said that for every dollar spent on petroleum facilities, another dollar has gone into community, transportation, and public-utilities facilities. These nonindustry expenditures have, of course, added greatly to production costs and have offset the advantages of the prolific nature of the Middle East oil fields.

Changes in the Middle East

The very large income from petroleum operations has been a windfall to the countries of the Middle East, many of which had previously subsisted on what amounted to a pastoral economy. The governments are increasingly showing a sincere desire to better the welfare of their peoples and they are themselves investing larger proportions of this revenue in their own national social services. This is a very commendable trend.

At the same time these internal developments are taking place, there are external factors at work. There is ever-increasing contact by government leaders with the more advanced economics of Europe and North America. This

ON A SUNNY MORNING in 1952 nine men walk to work. They are Australians walking into the biggest thing their country has seen for years, a 3-year epic that will change a desolate area of scrub and sand into the Continent's largest, most important oil refinary: Kwinana!

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Here is the familiar 20th Century skyline: slim, steel towers, bulbous spherical storage tanks, the huge tower of the catalytic cracking plant dominating a landscape where miles of pipe stretch across the sand.

And for the men who work at Kwinana there is a township to settle in, to bring up their families in. History is being made, a future is being born.

Behind the achievement is the Kwinana Construction Group (Pty.) Ltd. This consortium of three British companies was formed to build the entire plant for Australasian Petroleum Company (an associate of the British Petroleum Co. Ltd.) to the designs of the M. W. Kellogg Co. and the Kellogg International Corporation. So successful has this consortium been that the association will continue to build and to design similar installations throughout the world.

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has resulted in a more acute interest in political and business matters.

This particular situation is complicated by the nationalistic feelings which have become so intense in the countries in the Middle East. Extremists have used the oil companies as symbols of foreign exploitation. In the case of Iran, they succeeded in ousting the operating company from the country altogether.

Iran . . . The Iranian crisis, which developed in 1951, further involved the international oil companies in a critical siutation not of their own making, but one with which they were asked to cope nevertheless. When Iranian oil was denied to the free world in 1951, overnight cutting off 700,000 bbl. a day of crude and products, the immediate problems of supply could only be solved by private companies. Crude and product movements throughout the world were dislocated, but this resourceful industry of ours saw to it that no esesntial oil requirements of the free world were left unfilled.

A number of government missions from the United States and the United Kingdom failed to get the Iranian fields and the great Abadan refinery back into operation. Finally our National Security Council became so concerned that the State Department asked the American companies to work out the solution. The result was that an international consortium was formed which succeeded in restoring Iranian oil to world markets, and thereby brought the Iranian economy back from the brink of disaster.

This was not an easy solution. It involved many months of negotiations, during which the principals of the companies crossed the Atlantic several times. It involved the delicate task of reaching an agreement which, on one hand, would not breach the equitable principles established in the Caribbean and other producing countries of the Middle East, and, on the other hand, would be politically palatable to the nationalistic Iranians and the proud British.

It involved currency questions; the problem of dividing the ownership between the eight companies of American, English, Dutch, and French nationality; the consideration to be paid British Petroleum for its rights; and finally the complicated negotiations to arrive at a contractual arrangement for operations and offtake between the participating companies.

Solution of this problem was not a task which was sought by these companies. They already had ample supplies available from other sources. Restoring Iranian production was something which had to be done in order to put the Iranian economy back on its feet and keep Iranian oil from going behind the Iron Curtain.

Currency and trade . . . Not the least of the everyday problems faced by international oil companies is the ever-present "dollar shortage." In the good old days before World War II, there was complete interchangeability and convertibility of foreign currencies, but World War II counted among its effects the severe weakening of most foreign currencies. The international oil companies and, for that matter, all American industries with export markets were faced with this currency problem.

The Marshall plan, and its successors, ECA and MSA, provided essential dollar exchange for the countries of the Eastern Hemisphere, but this was not a complete or final solution. In 1949 and 1950, for example, the British Government announced a program of substitution of so-called sterling oil for dollar oil.

Had this become effective, the markets for the United States companies would have been severely restricted and their relations with governments of foreign oil countries would have been jeopardized. After prolonged negotiations, and with the welcome assistance of the United States State Department, the British tempered their plans and the American companies were permitted to compete with British companies on equitable currency terms.

The arrangements with the British Commonwealth were soon followed by similar agreements with other Western European countries. The result was that to stay in business in the Eastern Hempisphere, American companies had to reorient their purchasing and operating programs to utilize the various foreign currencies generated by sales of crude oil and refined products. Middle Eastern governments were also cooperative in these arrangements and agreed to take various proportions of the currencies generated by sales to consumer countries.

A case in point is California Texas Oil Co., Ltd., called Caltex, which operates in 67 countries outside the Iron Curtain. Caltex, as well as other American oil companies operating abroad, is buying most of its equipment, supplies, and services in the sterling area, in France, in Scandinavian countries, Italy, and Germany. These companies would rather have purchased here in the United States, but it was a case of survival in competition with foreign oil companies.

Freedom to compete for and utilize foreign currencies has its corollary in the necessity for freedom from trade restrictions.

Maintenance of reasonable freedom of action, and minimizing currency and trade restrictions are extremely important to the governments of the oil-producing countries overseas. Their friendship for the United States, their commendable long-range development programs, their policies of encouraging foreign investment, and our own national security depend in no small measure upon orderly development of foreign oil resources and the accompanying revenue from petroleum operations.

Growing Foreign Demand

Despite the foregoing obstacles, which have become almost routine to expect in the day-to-day conduct of foreign oil operations, the international oil companies have succeeded in developing their concessions to a degree which is commensurate with the oil requirements of the modern free world.

The United States, which no longer produces all of the petroleum it consumes, is playing a decreasingly important part in supplying oil to the countries beyond its own boundaries. Middle Eastern oil and, to a lesser extent, Caribbean oil are filling the breach formerly supplied by export from the United States.

Western Europe, whose booming demands offer the greatest challenge to the international petroleum industry, is being largely supplied by Middle East resources. The 80 per cent of European requirements previously mentioned as being supplied by the Middle East can be expected to increase to 90 per cent or more in 5 years.

For a great many years the United States has consumed most of the world's oil. Our consumption is, of course, increasing; but we will soon reach the day when petroleum utilization in foreign countries will equal ours. Ten years ago consumption of petroleum in foreign areas outside the Soviet sphere of influence was only about 40 per cent of their current use of some 5,300,000 bbl. daily, and 5 years from now it is reasonable to expect that it will reach a level of 7½ million barrels per day.

Including the United States, it appears reasonable to expect that the daily petroleum consumption of the free world will increase from the present level of 13 million barrels to 17 to 18 million barrels in 5 years. The implications of this for the petroleum business are, of course, tremendous. The great surge in the demands of foreign countries will be brought about by industrial and transportation expansion, and also by increasing per capita usage of petroleum.

If per capita demand in Western Europe were to increase to anything like the level of our own utilization, requirements for petroleum would skyrocket; and if the countries of Asia are successful in their modest develop-

ment programs, per capita utilization of petroleum could easily double within a comparatively few years.

Energy requirements . . . A very important sector of demand for petroleum pivots about the coal situation in Europe. No one would disagree that the European coal industry has failed to expand its output commensurate with advances in industrial activity. Europe, like the United States, is enjoying an economic boom. The amount of coal being mined and consumed is increasing moderately, but not fast enough. The widening gap in energy requirements is being supplied increasingly by petroleum.

The declining position of coal is apparent in these estimates: Where coal supplied 83 per cent of European energy in 1938, it now only supplies 70 per cent; and it is expected that by 1975 it will serve only 52 per cent of the market. It is interesting to note in this connection that employment in the coal mines is no longer the burning issue which it once was in all European countries. With employment opportunities available elsewhere to attract young men, and with the ranks of older miners being shrunk from the natural process of attrition, the mines are now actually shorthanded.

The British Government recently conceded that its coal program had fallen short of the requirements of the nation, and that Britons would have to depend on oil to supplement their energy needs for the next 10 years, or until industrial atomic power is available on a commercial basis. Such an announcement several years ago might well have precipitated a vote of confidence in parliament and a general election. Today it is taken in stride, an obvious admission that there is no longer reason for protecting coal employment.

Currency problems can be expected to continue, although becoming less important. Perhaps some European countries, for reasons of their own, will discriminate against petroleum in favor of coal; but these problems cannot deter Europe from moving toward far greater utilization of petroleum fuels. This is the key to further European industrial expansion.

Changing product demand . . . As a result of the changing pattern in furnishing Europe's energy requirements, we find petroleum demand is shifting from an emphasis on light products to one on heavier fuel oils. European refiners which outfitted their plants after World War II in anticipation of continued light-product demand, now find their cat crackers not operating to capacity and their product yield ratios out of balance with market requirements.

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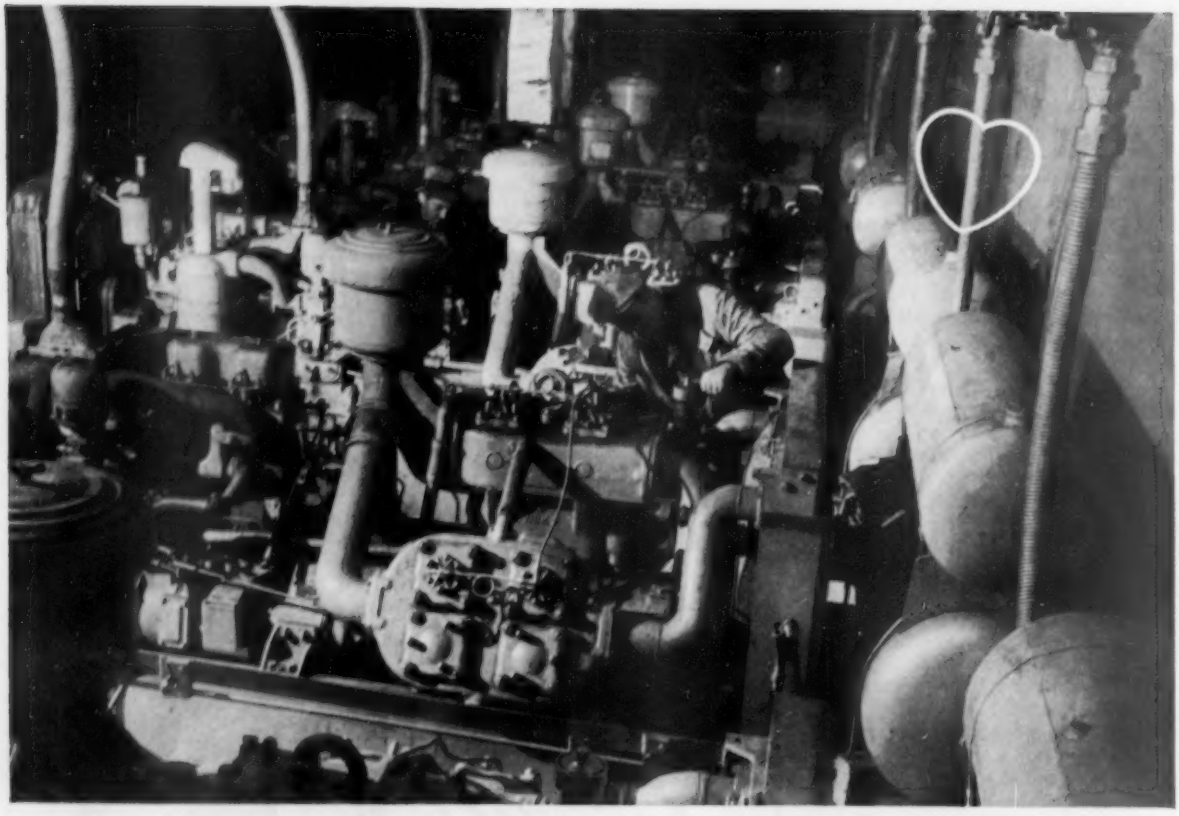

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This situation poses other problems for the international oil companies, most of whom are engaged in refining. With heavy-fuel demands soaring, they must virtually "downgrade" their refinery output. This carries with it the question of product price structure. Prices in Europe have been determined on the basis that gasoline was the primary earner.

If the continuing trend is toward a lower yield of gasoline to crude and a simultaneous higher yield requirement for fuel oil, it may be expected that heavy fuel-oil prices will strengthen. The future may prove this to be essential for the European refiner to maintain his earnings at a reasonable level.

Europe's soaring demand for fuel oil will undoubtedly have its effect upon the fuel-oil situation in the Western Hemisphere. If either or both the continent and the United States experience a very cold winter, the ability of the free world to produce enough fuel oil may be severely taxed.

As a point of interest, it should not be inferred from the preceding remarks that the European refiners are not capable of adjusting to increases and changes in demand. Just prior to World War II Europe refined only a third of its requirements and imported the balance in finished products. Today the region is virtually self-sufficient in refining and dependent upon crude oil from the Middle East rather than products from the Western Hemisphere. What is now required is reorientation of refining yields.

What has happened in Europe is happening, although to a lesser degree, in many other foreign countries. Desire for full employment and foreign exchange earnings has caused many countries to embark upon local refining projects. Often this involves programs which are not strictly economic and the international company faces the problem of delicate balance of government relations in choosing sites for refineries.

Conclusion

One underlying factor has enabled the international oil companies to surmount the unique and often discouraging obstacles discussed here. This is the principle that America's interests are best served by free, competitive enterprise.

It is no accident that 90 per cent of the world's oil reserves is now in friendly hands. This came about mainly through the diligent world exploration of private, international companies. It came about because these companies were not unduly restricted by governmental regulations, and because their operations were flexible enough to adjust to geographic circumstances and those imposed by current events.

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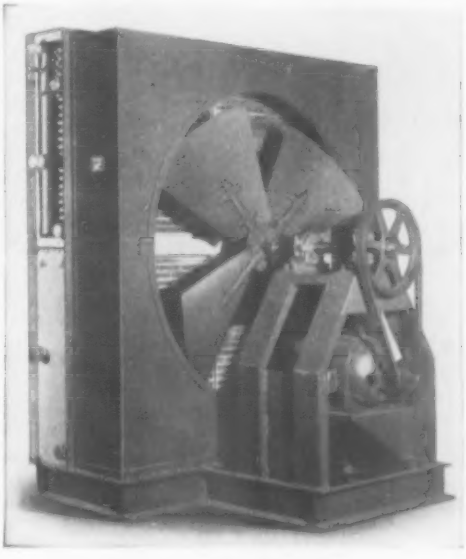

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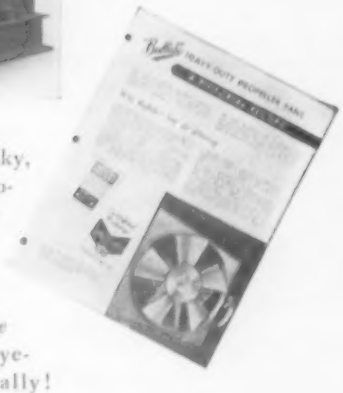

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Not What, but . . .

Who Is Behind the Balance Sheet

Management development is not something that top management can assign to the personnel department, or something that university extension courses can do for a company. The task is essentially a function of management

by O. C. Roehl

MANAGEMENT potential is the most important single factor in security analysis and, at the same time, management evaluation is the most difficult task facing the financial analyst. Who is behind the balance sheet is usually more important than what; and although the evaluation of the human factor in business is difficult, yet it has to be done and it is done.

The appraisal of management by security analysts and investors may be incomplete, but the fact remains that management is carefully weighed; and although the security markets may not always give a thoroughly reasoned or informed evaluation, yet they do offer an objective test of management and in the long run the decisions of the market place have a way of being quite correct.

It may take a few years, but poor management is always found out and good and improving management always ends up with more and more of the investors' dollars entrusted to it—until, of course, it, too, begins to lose its touch. In the long run the security markets provide a good index of the efficiency of corporate management.

Author is vice president, Keystone Custodian Funds, Inc., Boston. Paper presented at annual meeting, A. P. I., San Francisco, November 16, 1955, under the original title, "Management Potential at the Market Place."

Management measured . . . The management of every business in our economy is continually being measured and appraised by its customers, employes and shareholders and we in the investment business are no exception. The quality of service we render the men and women who entrust their savings to our care determines our success. Our success, in turn, largely depends upon the success of the businesses in which we invest the savings of many thousands of investors.

As our shareholders are not short-term investors who attempt to make money through speculating in the day-to-day moves of the securities market, but rather build their future on the economic success of the businesses in which we have invested their money, it is most important that we select companies with good, present-day managements that give promise of continuing good management in the future.

Appraising Management

The investment-company industry and investors generally are therefore paying more attention than ever to the question of management and management development. It is the strict policy of our company that our portfolio managers and industry specialists, in their comparative security analysis work, appraise the management of every company they may be considering for investment.

They are required to assign a rating of superior, good, average, or poor to every management; and these ratings are often the determining factor in our investment decisions. No company would be rated superior or good that did not have a definite program for management improvement, continuity, and development. However, no one can profess to be an expert at management evaluation as the subject is so very complex and difficult, but management appraisals are made and the management factor will become more important in general comparative security evaluation in the years ahead.

One thing is sure — investments in companies with superior managements have worked out better than investments in companies with average managements; and we are convinced that the efforts made to evaluate management are well worth the work put into them. One of our directors, Prof. Erwin H. Schell, now professor emeritus of Massachusetts Institute of Technology, has discussed our attempts at management evaluation before various business groups. I will be glad to send a copy of his notes on "Appraising Industrial Administration" to anyone who may be interested in this general subject.

Today, with the rapid changes in customer preferences and with another technological revolution upon us, the very existence of a business is more than ever dependent upon the quality of its management. The shortage of top-grade managerial talent is going to be even more of a problem in the next decade and every progressive business is paying a great deal of attention to management development. From the investor's point of view, competent management is a most comforting asset in the period of rapid change in which we find ourselves, and the premiums

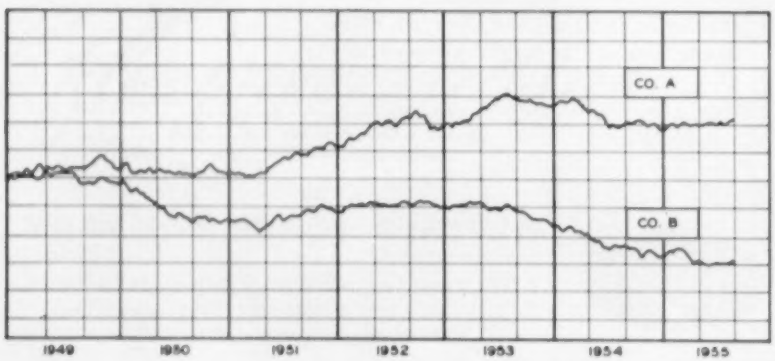
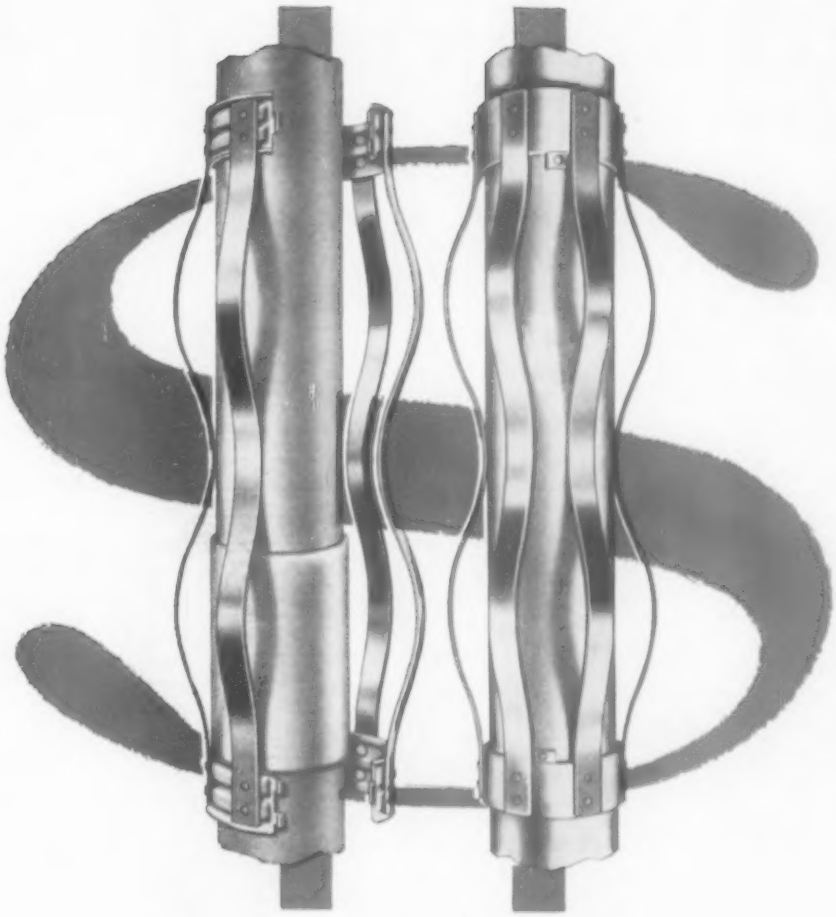


Chart 1—The relative stock-market performance of two comparable utility common stocks compared to the performance of 275 investment-grade common stocks of all industries, 1949-1955.



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being paid for good management are well worth the price.

Importance to Investors

The importance of management to the investor can readily be demonstrated by looking at a few examples.

1. **Chart 1** shows the relative security market performance of the common stocks of two utility companies operating in generally the same area:

$100,000 invested in Company A in 1950 has grown to $220,000 today.

$100,000 invested in Company B in 1950 has grown to $121,000 today.

Both are large companies and Company B's problem has been primarily a management problem. A few years ago the management was changed and investor confidence began to grow, but the new management must still prove itself. The economic loss to the shareholders, employes, customers, and the public has been great and should have been forestalled.

Twenty years ago Company B was a leader in its field, but somewhere along the line management development was not given sufficient attention.

2. **Chart 2** shows the relative market performance of four large oil companies:

$100,000 invested in Company A in 1950 has grown to $250,000 today.

$100,000 invested in Company B in 1950 has grown to $265,000 today.

$100,000 invested in Company C in 1950 has grown to $265,000 today.

$100,000 invested in Company D in 1950 has grown to $374,000 today.

Again the problem has been largely one of management. The managements of both Company B and Company C have been changed during this period and Company A's management has been greatly improved. If one were to analyze the market action, one could almost spot the times when the management changes were made.

To my mind, the management-improvement job that Company C is doing is still not fully appreciated and I am sure you will see its relative performance line go up further over the years ahead. Company D has long been a leader in management development and the results achieved by its superior management are reflected in the price of the company's securities.

Top management is key . . . Every success or lack of success, every error of judgment, every good move is ascribed to management. You may hear it said that this chemical company's area of research is not right and it needs a new research head. In another company the problem may be friction at the top and in another, poor execution down the line. But always the problem is deposited at the door of management, as it should be, and it usually ends up with top management rightly or wrongly receiving credit or the blame.

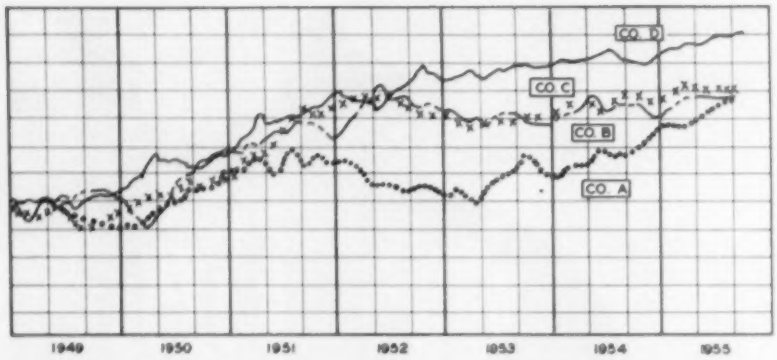

Chart 2—The relative stock-market performance of four oil-company common stocks compared to the performance of 275 investment-grade common stocks of all industries, 1949-1955.

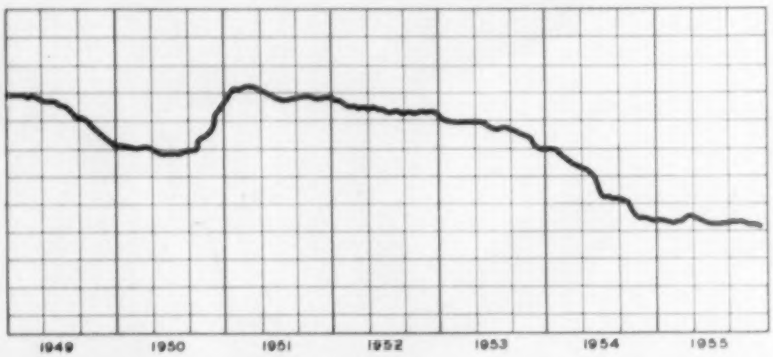

Chart 3—The relative stock-market performance of a company active in management development programs compared to the performance of 275 investment-grade common stocks of all industries, 1949-1955.

Although management teamwork all up and down the line is needed, yet leadership at the top is still most important. We were recently briefed on a study that has just been completed covering an analysis of various New England cities that have lost their textile industries. As you know, some of these cities have staged a great comeback. Others are still going downhill. In each instance the difference was due to one to three men in the comeback towns who decided to do something about the problem—the other towns lacked the needed leaders. So in business and perhaps in every area of human endeavor one always gets back to the general question of "management."

Superior management is definitely worth more than good or average management, and it may be interesting to conclude this phase of our review by trying to put a price tag on the importance of top-grade management. The common stocks of United States corporations publicly held, both listed and unlisted, are valued at close to 250 billion dollars, with the shares of the petroleum and gas industry valued at about 35 billion.

Superior management is generally evaluated at 30 to 35 per cent higher in the securities market place over average management and good management is worth at least 15 to 20 per cent more than the average. The poorly managed company can only struggle for its very existence. Over the years that we have rated managements, we find a few superior managements and a number of good managements, with most managements being rated average.

I would venture a guess that an improvement in the quality of the average United States business management to good or superior, would add at least 75 billion dollars to the market value of the securities, and in the oil industry maybe what we are talking about could be described as an 8-billion-dollar problem. If one were to make an estimate of the monetary loss of poor management to investors, employes, and the economy as a whole, almost any estimate would be too slow. The importance of good management and the need for management development from the viewpoint of investors hardly needs more comment.

Management Development

Most businesses have recognized the fact that reserves of managerial talent

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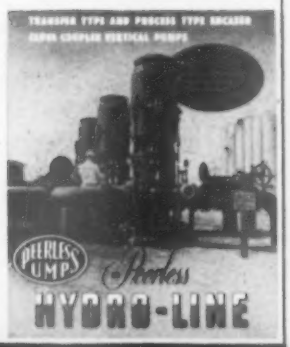

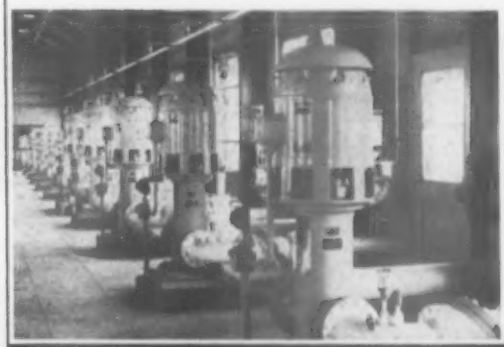

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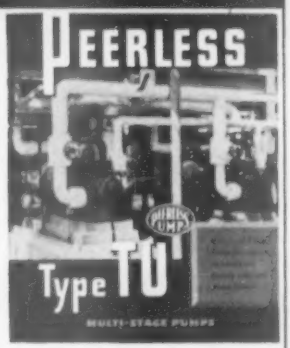

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"How Tough Can a Pipeline Job Get?"

...asks the Oil and Gas Journal, Aug. 29, 1955, page 72

Laying Tennessee Gas Transmission Company's 24-inch pipe line into the metropolitan New York area involves many unusual problems.

One of the most difficult was construction in the populous city of White Plains, N.Y. Pipe was laid under a heavily travelled main parkway. Ditches had to be freed of water by an extensive dewatering system, and the Bronx River caissoned by sheet piling and sand bags.

Under these rugged conditions pipe laying was completed and the highway restored to traffic a little over one week after equipment moved in.

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are just as important as, for example, reserves of oil are to your industry. Today there is hardly a business enterprise that has not made some attempt to evaluate and appraise its personnel and to establish a management development program encompassing both internal and external training courses. Last year more than 53,000 executives attended the American Management Association meetings; and the courses at Harvard, Stanford, M.I.T., Wisconsin, and other institutions are attracting more people than can be accommodated.

Even the financial analysts are getting into the act and a course for them is being established this year at Beloit University. This is all healthy and good. But let us take a look at all of this activity from the point of view of the investor, the shareholder, the owner of the business.

In our work one of the first things we inquire about so far as management is concerned is the question of management development and the provision for the future. Unless management continuity is provided for, there is not much continuity to the business. It does not make much sense to spend a lot of time planning physical budgets covering expansion programs for the next 5 to 10 years, and at the same time not plan for and train the management and other personnel that will be needed.

We would think more than twice about putting money entrusted to us in a company that did not have a pretty good idea where its management for its present and future business was coming from 5 or 10 years from now. The continual upkeep of human resources is perhaps more important than the maintenance of physical equipment. Changes in the art of management are being made just as fast as changes are being made in equipment and process.

Evaluating future needs . . . I was talking recently to a consultant for a large electrical company and one of this company's primary concerns is the problem of finding men to staff the managerial positions that will need to be filled in its expansion program now being planned well into the 1960's. The fact that this problem is of concern to top management and that something is being done about it reflects the kind of management this company has, and like competence in other management responsibility areas is perhaps the primary reason for its outstanding success compared to that of its competitors.

Although management development, training, and evaluation programs are good and necessary, yet executive-development programs aimed at the future are not going to make up for defects that exist in the management of the company today. Management-development programs are not going to compensate for the lack of a sound research program, a weak sales approach, inept financial planning, a poor tax department, or unsound management organization.

It appears to us, looking at business management from our vantage point, that more attention needs to be given to present-day problems in many companies before the companies can get the most out of their management development programs.

Make audit now . . . Before a company management can really talk about and plan a sound management development activity it must first make an audit of itself. Is it really doing a good job? Is it successful compared to others in its industry? Does it have able financial, sales, and manufacturing management? How many new products have been introduced by the company's research work compared to those of its competitors? Is the company ready with product improvements that will be required in the next 5 or 10 years? Are the trends of profits in each department favorable?

If the answers to these questions are not what they should be then the question is, why aren't they? This question needs to be continually reviewed and answered as the first step in any continuing management-development program. What to train for and where training is needed must be answered by top management before intelligent development can begin.

Perhaps a management-development program should start with the company's board of directors. The board has a great responsibility for the quality of a company's management. Unfortunately there are many examples in business today where the boards are not completely fulfilling their trusteeship functions. It would seem that a periodic independent review of present management and company objectives is just as necessary as a program for the development of future leadership.

Organization plan . . . One of the more important items in the audit of any business and most important to effective management and management development is the company's organization plan. There are certain fundamentals of good organization which must be observed before a sound management development program can be established, and a sound organization plan has provisions within itself for the continuance of good management in the future.

A poorly conceived organization plan is a handicap to management development. There are many examples where coordination between departments within a company is so poor that it cannot operate at anywhere near its maximum effectiveness, and management development in such an atmosphere is wellnigh impossible.

When the objectives of a company are clearly stated and understood, and when its organization plan is soundly established, then only can management effectively look after the management development phase of its responsibilities. From our experience there seems to be a trend towards the establishment of more coordination committees within industry, and industry also seems to be utilizing the general-staff approach to a much greater extent.

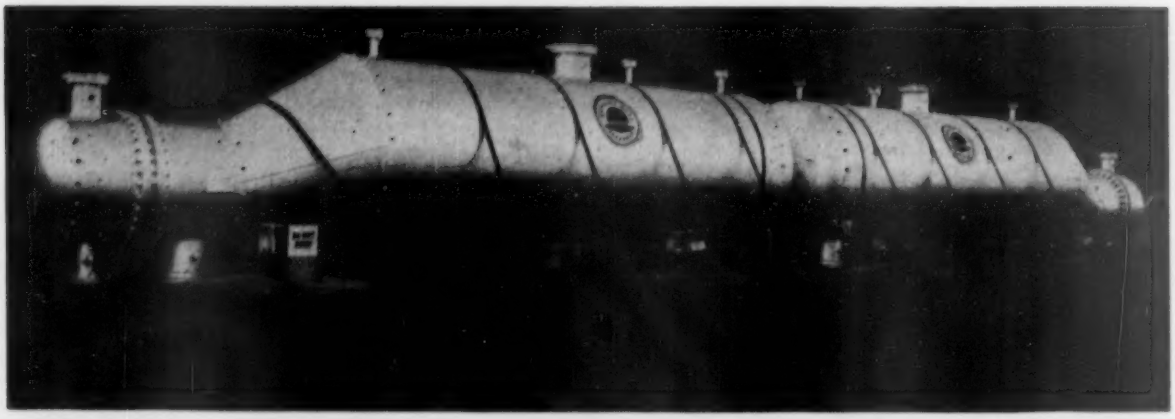
This all seems excellent. Although committees cannot be responsible for executive action, yet they are indispensable as coordinating vehicles and they offer excellent training grounds where much-needed experience in handling practical day-to-day management and operating problems can be obtained.

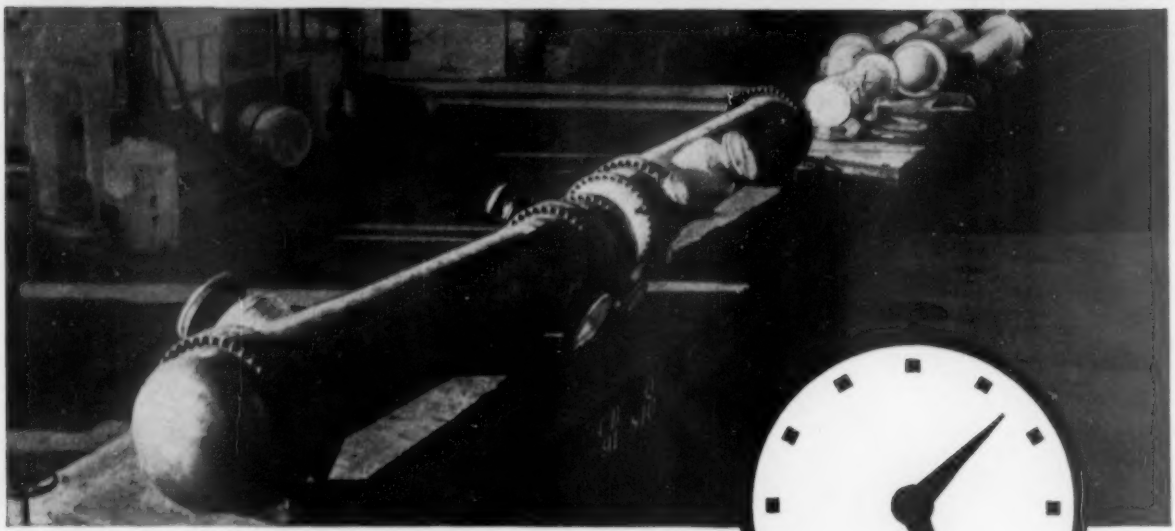
The use of the general-staff concept also provides for the future development of top management in that the staff, which is usually made up of men who have had their major experience either in sales, production, research or finance, obtain through their staff work an understanding of the broader management problems that face a company. The company therefore has a more capable and better rounded group from which leadership in the future can come.

One of the greatest puzzles that always confronts the financial analyst is the company that looks good from the outside but is not nearly as solid as it appears. One runs into such companies in the management-development field, too. For example, here is a company (Chart 3) that has had an extensive management-development activity and its program has been highly publicized. But with all its talk about management development the company has not kept pace with its industry nor with industry in general. Maybe the company has paid too much attention to talking about management development and not enough to actually doing a first-rate job today.

Another somewhat related example of a weakness in management-development programs came to my attention in a discussion I had recently with the head of one of our well-known companies. I had before me the detailed management-development program of another company in the same field. I have never seen a more thoroughly documented program — appraisal forms, psychological tests along with a chart of future management requirements.

The report spoke of the great success





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the company has had in its work and considerable space was devoted to one specific example of actual managerial talent that had emerged from the program. I mentioned to my friend that this sounded very good. His answer was, "Well, they're right about that man, because I hired him." Somewhere something was lacking in the management-development program of that company.

What to look for . . . Industry is trying as never before to develop and train a reservoir of managerial talent and the recognition of the problem is important; and perhaps one of the very best things about the programs is the fact that good men do not have to worry so much about getting lost in a big organization as they used to, because the management-development program gives them a chance to grow and to show their stuff.

Just what the training programs should cover depends primarily on the man and the company, but they should be aimed at producing the qualities that distinguished leaders seem to have. An article in a recent issue of the U. S. Naval Institute Proceedings sums up these qualities in a way that makes sense.

The author, Edmund A. Gibson, recounted all the many admirable characteristics that are supposed to make a good leader, but he rejected most of them on the basis of his examination of military leaders; and he concludes that the great leaders had three things in common:

1. They possessed a tremendous amount of knowledge, skill, and ability in their profession;

2. Each, besides his military education, had an extensive acquaintance with the liberal arts (education in history for the ways and habits of men and nations; education in philosophy for the art of clear thinking; education in literature for the very essential art of expression; education in general for the acquisition of the cultivated tone which commands respect even from unlettered men); and

3. They were all shrewd and accurate judges of men (including ability to judge character and to maintain strict discipline).

The tremendous capacity for achievement that real leaders have is not obtained in 10 easy lessons. It comes by everlastingly working at it. Today most progressive companies are giving their managements opportunity for development, and it is interesting to note some of the experiments in the educational field such as Bell Telephone Co.'s experimental "Humanistic Education Program" at University of Pennsylvania and the course being offered this year

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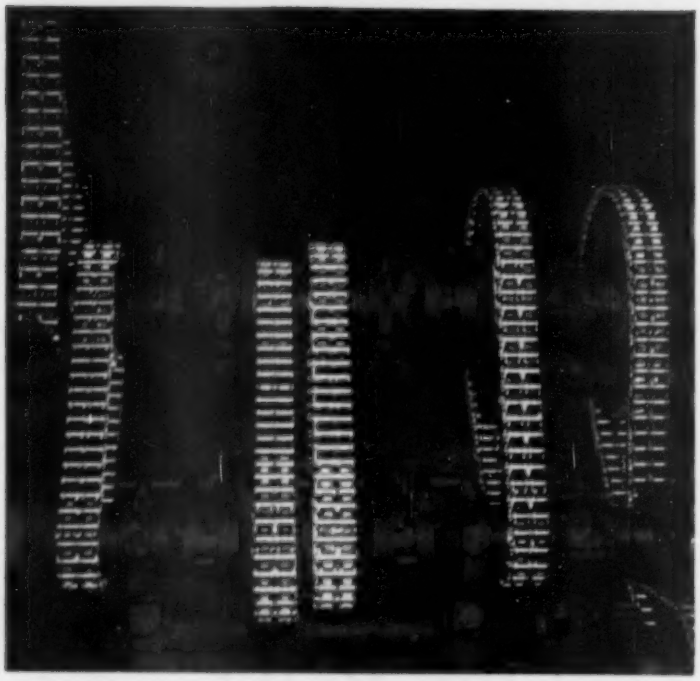
"Morse H-E Roller Chain gives superior performance on tough drilling jobs"



Morse HE-120-2 and HE-140-2 High Endurance Roller Chains and Sprockets were used in MC-250 Bethlehem rig. They efficiently compound power from two 195-hp WAK Waukesha engines. H-E Chain is available in single and multiple widths, in standard- and heavy-series chain, in all pitches from 1¼" up.

Exclusive Spirol Pins absorb shock, resist vibration. Cannot shake out, crystallize, or break off like cotter pins. Standard on Morse H-E Roller Chain.

"After 18 months of 24-hour-a-day duty, the Morse H-E Roller Chains in our Bethlehem Draw Works still looked as good as the day they were installed. We believe these chains to be superior to any we have used before in this transmission."

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Maintenance Superintendent

The Morse High Endurance Roller Chain shown at left was subjected to 18 punishing months of continuous operation in a workover rig transmission. In all that time, not one cent was spent for chain maintenance; not one minute of downtime occurred due to chain repairs.

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at University of Virginia's new graduate school of business administration entitled "Organization, Human Relations, and Administration."

Self development required . . . Management development, however, is not something that top management can assign to the personnel department or something that Stanford or M.I.T. or the A.M.A. can do for a company. External helps are good, but the job is primarily and principally a function of management. Although the art of management can be developed and is teachable, yet executive development seems to be essentially self-development; and every executive worthy of the name must do much of his development work for himself.

A company can help him get experience and training but, as one man in the oil industry to whom I was talking about this subject said to me, "If a man doesn't have it in him, 1,400 years at Harvard isn't going to give it to him." Maybe managerial ability is somewhat akin to artistic ability. A man can be taught color, perspective, and all the technical aspects of good painting but that still will not make him an artist. Something of the artist must almost be born in the man—then only will the training do the most good.

Unquestionably one of the main responsibilities of business leadership is to see that the quality of its management is continually improved and that the continuance of like or better quality management in the future is also assured. This can only be accomplished if top management puts some of its time and effort into it. For example, if management assigns money to research, it also has to assign some of its time to see that something comes of the investment. If it has a management-development program, it must also give active support and time to it and see that every department in the entire company also follows through.

Our whole way of life is fundamentally dependent upon the quality of our management. Peter Drucker, in his excellent series of articles in Harper's early this year, said:

"During the period ahead, in any event, the greatest need for innovation seems more likely to lie in the social rather than in the technological area. Indeed, the technological revolution itself will be totally unproductive unless it is accompanied by major innovations in methods, tools, and measurements for doing the managerial job in the modern enterprise, large or small; for the development of competence, skill, and imagination among managers (still considered a luxury by many companies) is probably the greatest necessity any business, let alone economy, faces."

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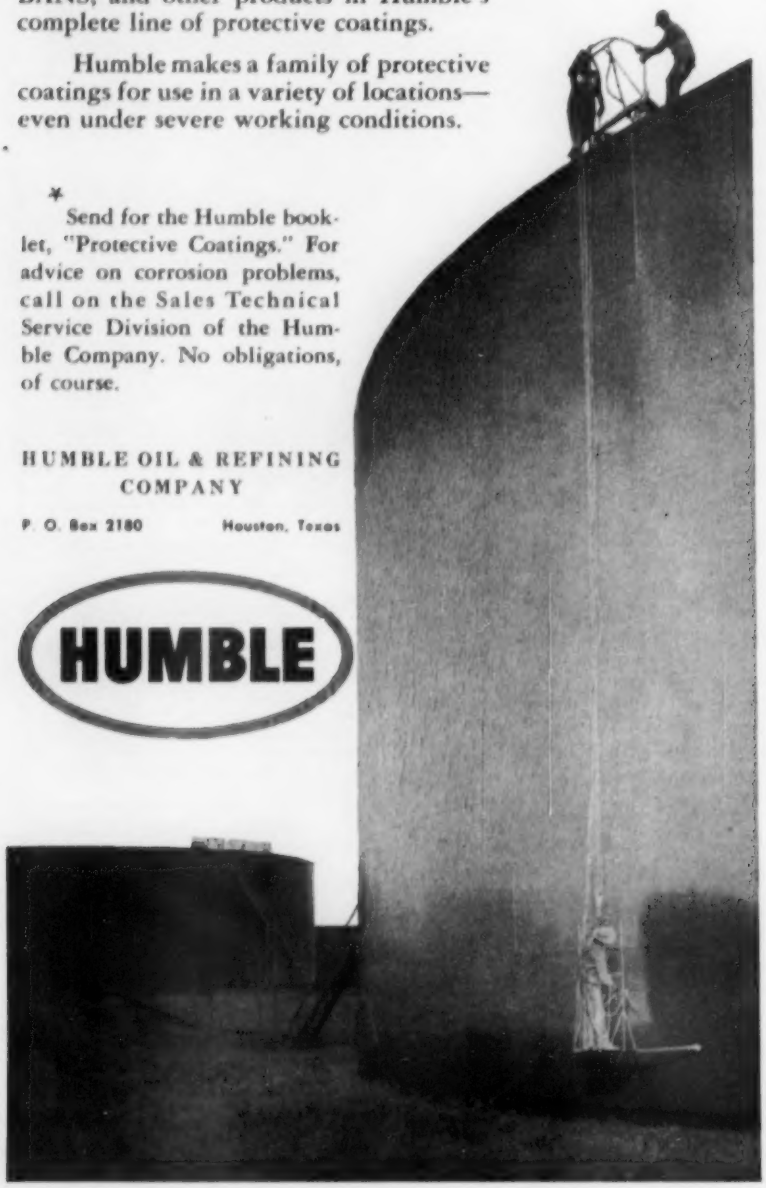

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Paint Storage Tanks White—and Save

And to take the greatest advantage of white paint in reducing evaporation losses, use the self-cleansing type—experts call it "controlled chalking"

by E. L. Hoffman

THE outstanding performance of white paint as a simple effective means of reducing evaporation loss has been well established. Evaporation losses of volatile petroleum products are costly, whereas the cost of maintaining a clean white tank is relatively low.

● Data favoring a white roof are voluminous and irrefutable, and have been described in detail in the literature. The conclusion in regard to white roof for cone-roof tanks applies also to the roofs of variable-vapor-space tanks, e.g., wet and dry-seal lifters and flexible-diaphragm tanks. This conclusion does not apply to the roof of a floating-roof tank, inasmuch as a self-chalking white paint is not practical.

● In the case of the shell it is obvious that, if heat transference through the shell is greater than through the roof, conclusions in regard to the roof are also applicable to the shell. The only data which discuss the color of the shell paint on cone-roof or atmospheric tanks are the data supplied by Smith and Harden.[22] These data have been well documented, particularly with reference to heat transfer through the liquid and vapor phases in tanks up to 80,000 bbl. in size.

● In the light of previous findings on heat absorption, additional evaporation savings are made possible by painting the shells of such a tank white. These savings result in an excellent payout if chalking white paint is used.

● This recommendation does not apply to the shell of variable-vapor-space tanks nor to the shell of the newer floating-roof tanks. On the older floating-roof tanks the shell is frequently riveted. When such tanks are used to store gasoline, savings in breathing loss again warrant the use of a white shell paint. Where crude oil is stored in older floating-roof tanks, each case must be considered on its own merit.

At the present time, many oil companies use white on both the roof and shell of tanks storing volatile products. In some cases this procedure was followed prior to the Smith and Harden article. These companies include Phillips Petroleum Co., Standard Oil Co. (Indiana), Standard Oil Co. (Ohio), and some terminals of Shell Oil Co. and Esso Standard Oil Co. Socony Mobil, which paints roofs white, is giving consideration to painting the shell white.

Author is with Socony Mobil Oil Co., Inc., New York. Paper presented at annual A.P.I. meeting, San Francisco, November 14, 1955, under the original title, "The Effect of Paint Colors in Reducing Storage-Tank Losses."

Newer Tank Colors, Pastels

In regard to the newer tank colors now appearing on the market, aluminum—in its ordinary form or in any of the tinted varieties—is not recommended for either tank shell or roof for volatile-product storage. Certain of the pastel colors, such as cream or light yellow or light blue, may be used on the shell of the tank for eye appeal, inasmuch as there is only a slight loss in reflectivity. However, tank-shell paint must have self-cleansing properties to a comparable degree with the white paint which would ordinarily be specified.

Controlled Chalking

High solar-heat reflectance is maintained only by controlled chalking. During early exposure white paint collects dirt and grime. However, in a short time the accumulations should disappear. This necessary and favorable action is brought about by controlled chalking. Self-cleansing, as one would expect, proceeds only at the expense of the paint film, which gradually weathers away and becomes thinner. It is thus seen that the requirements—maintaining high solar-heat reflectance and providing long life and protection—are working one against the other.

However, with modern highly durable alkyd vehicles and proper selection of the titanium-dioxide white pigment, the paint technician produces paints which either accelerate the chalking rate or delay it to practically any desired degree. We may thus produce a tank white paint which weathers very slowly, providing extremely long life and protection. Such a paint will soil objectionably and defeat the purpose for which it is used—high solar-heat reflectance. On the other hand, we may accent the chalking rate to such a high degree that reflectance is maintained at the expense of durability. However, with proper formulation chalking may be satisfactorily controlled and a balance struck between the two major requirements—whiteness and durability. From present indications the preferred method of tank paint application will involve the long nap roller. It gives the best coverage of paint and is the most economical in regard to labor costs.

Data Review

Schmidt and Wilhelm, two U. S. Bureau of Mines petroleum engineers, made exhaustive tests on the reduction of evaporation losses in cooperation with the State of Oklahoma, and the results of their tests are frequently quoted in subsequent reports. In one of their tests, five 12,000-gal. horizontal tanks were each painted with a different color and tested during 4 summer months.

Another 12-month test conducted by this bureau involved four 55,000-bbl. crude-oil tanks painted different colors (Table 2). This test indicated that the black-painted tank lost 649 bbl. whereas the aluminum-painted tank lost only 447 bbl. during the test.

Another U. S. Bureau of Mines test was made by exposing tanks of various colors to the rays of carbon arcs for 15-minute periods and observing the rise in product temperature. Tests were also made on four 55,000-bbl. crude-oil tanks covering a period of 1 year.

Phillips Petroleum Co. made tests on nine 55,000-bbl. tanks covering a 3-month period in the summer of 1936 and again at a later date.

At various times tests have also been made using many other materials in an effort to limit heat input. Such materials included insulation, sun shades when wind conditions permit and, more recently, aluminum shades supported on a cone roof by aluminum trusses. Water sprays and water blankets on the roof have also been used in the past. All of these methods will decrease evaporation losses but, with the possible exception of the aluminum shades, the other devices have generally proved economically unfeasible.

All test results, regardless of equipment or method, pointed to the same

"The impossible . . . takes a little longer"

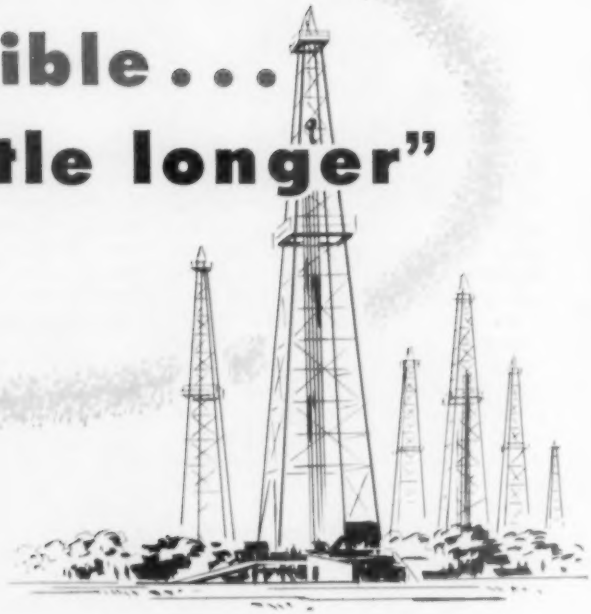

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TABLE 1[22]—EVAPORATION LOSSES IN LARGE STORAGE TANKS PAINTED ALUMINUM AND WHITE RESPECTIVELY

Quantity measured—	Time period	New aluminum paint	White paint	Ratio of aluminum to white
Vol. of hydrocarbon vapor vented (at 60° F. and 760 mm. of mercury), cu. ft.	9-24-51 to 10- 6-51	193,334	148,010	1.3
Avg. expansion in vapor phase, per cent	9-24-51 to 10- 6-51	6.4	4.7	1.4
Avg. gallonage, gal. per 1,000 cu. ft. of vapor	9-23-51 to 10- 3-51	10.0	7.9	1.3
Gasoline lost as vapor, bbl.	9-24-51 to 10- 6-51	46	28.0	1.6
60° F. liquid lost (tank gage), bbl.	9-24-51 to 10- 6-51	76.0	59.0	1.3
Liquid loss during initial time period—heat-absorption period, bbl.	9-19-51 to 9-23-51	35.0	18.0	1.9
Over-all liquid loss, bbl.	9-18-51 to 10- 6-51	110	77.0	1.4
Liquid lost (as determined by Chenicek Whitman apparatus), per cent	9-24-51 to 10- 6-51	0.266	0.20	1.3

general conclusion and, hence, it may be assumed that, in the aggregate, the tests were accurate.

Test Data—Roof Surface

1. Cone-Roof Tanks

In one recent test on the relative effectiveness of reflectivity of heat of various types and colors, a mirror or sun-shaded roof gave 100 per cent reflectivity; white paint, 90 per cent reflectivity; whereas black paint showed zero.

A report made in 1950 shows that the loss on a 90 by 42-ft. tight cone-roof tank which needed painting was 0.33 per cent of the throughput. The same tank with a good white roof experienced a loss of only 0.28 per cent. In terms of gallons of gasoline, this would result in a saving of 10,000 gal. annually, assuming the tank had 10 turnovers per year.

Different colors . . . A test conducted by H. A. Gardner (see Table 3) to determine the temperature and percentage loss by evaporation was conducted on small tanks of different colors, two-thirds filled with naphtha and exposed to the sun for 2 hours. The black-painted tank showed a liquid temperature of 110° F. with a 9 per cent evaporation loss. A cream tank and a light-blue tank both showed a liquid temperature of 102° F. and a 5 per cent evaporation loss, whereas the white-painted tank showed a liquid temperature of 100° F. and a 4 per cent evaporation loss. The white tank was the best, but it is interesting that cream and light blue have only slightly less reflective power. Another test by Gardner has been listed separately in Table 4 because one result in this test differs from the results of all other investigators. Gardner shows liquid-temperature rise in small tanks painted in various colors when subjected to rays of a carbon arc for 15 minutes. The liquid-temperature rise is 54° F. for black, 22.5° F. for white, and 20.5° F. for aluminum. The explanation for a lower temperature rise on aluminum than white was given later by Dr. Lotz,[5] who showed that the radiant energy emitted by the carbon arc is of different quality from that received from the sun. Although aluminum shows to advantage in the infrared region, it is definitely less efficient than white when confronted by solar radiant energy.

TABLE 2
Four 55,000-Bbl. Crude-Oil Tanks Painted Black, Red, Gray, and Aluminum

(Evaporation loss in 1 year)

	Bbl.
Black	649
Red	609
Gray	547
Aluminum	447

TABLE 3
Temperature and Per Cent Loss by Volatilization in Small Tanks Two-Thirds Filled with Naphtha and Exposed to the Sun for 2 Hours[23]

Color of tank—	Temp. of naphtha (° F.)	Loss of naphtha by volatilization, per cent
Black	111	9
Bright red	109	8
Dark green	108	8
Battleship gray	106	6
Tan	104	5
Red primer—white coat	102	5
Cream	102	5
Pale blue	102	5
White	100	4

TABLE 4
Rise in Temperature of Benzenes in Small Tanks Painted in Various Colors (Gloss Finish), When Subjected to Rays of Carbon Arc for 15 Minutes[24]

Color—	Rise in temp. (° F.)
Tin plate	19.8
Aluminum	20.5
White	22.5
Light cream	23.5
Light pink	23.7
Light blue	24.3
Light gray	26.3
Dark green	39.9
Black	54.0

Weathering . . . In an article by J. C. Albright, reported on in Table 5, the brightness of the painted surface before and after weathering is shown in tabular form. White is considerably better than aluminum in the unweathered state and, if a chalking white paint is used, it is also considerably better after weathering. However, white enamel, originally the best, suffers from dirt adherence and, accordingly, reflects even less light than aluminum after the weathering period.

Tables 6, 7, and 8 show additional data on reflective properties, and are of interest in that Tables 6 and 7 show that light gray is apparently better than aluminum. Table 9 indicates paint factors applicable to various colored tanks when computing predicted evaporation loss caused by breathing from atmospheric fixed-roof tanks.

Vapor temperature . . . In addition to the foregoing, when the atmospheric temperature is 85° F., studies show that the vapor-space temperature is about 21° F. above the atmospheric for white tanks, but 81° F. higher for unpainted tanks. Other studies along a similar line have indicated that the temperature of the vapor in a tank roof painted gray can exceed ambient temperatures by as much as 30° to 50° F. In the case of the white roof tank, the liquid temperature was 6° F. less than the atmospheric temperature whereas, for the unpainted tank, the liquid temperature was 3° F. higher than atmospheric.

In the preceding I have indicated results obtained from the literature to show extremes in variations. The data are tabulated. In a review of over 20 articles on the subject of light-colored paints for storage tanks, all but one of the reports show that certain light-colored paints applied to the roof had a marked influence on the reduction of evaporation losses. The important thought developed is that, by reducing

TABLE 5—BRIGHTNESS OF THE PAINTED SURFACES BEFORE AND AFTER WEATHERING[6]

Type of surface—	Per cent— Unweathered	Per cent— Weathered	Condition of film after exposure
White enamel	88	30 to 35	Dirt adhering.
White paint	85	55 to 65	Chalking considerably. Fairly clean on top of tank; dirtier down on sides.
Aluminum paint	56	35 to 40	Dull (appearance—somewhat dirty).
Metallic zinc—powder paint	25	10 to 15	No gloss remaining; slightly dirty.
Black			Dull appearance; chalking slightly.

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the variations of the temperature of the air-vapor mixture in a storage tank, a resultant decrease in evaporation loss can be achieved.

Reduce vapor temperature . . . The reason that light-colored paints reduce evaporation losses is that, because of their reflectivity, they reduce the variations of the temperature of the vapor space. In addition, the actual temperature of the vapor is lowered, and the surface temperature of the oil is decreased. This not only reduces the amount of the air-vapor mixture breathed by the tank, but it results in a decreased amount of gasoline vapor in the air-vapor mixture above the oil.

TABLE 6—"REFLECTION VALUES" OF SEVERAL PAINT COLORS*

Paints having the highest light reflective value should most effectively reduce tank temperature and show the lowest evaporation loss.

	Per cent
White	84
Light gray	53.6
Aluminum	41.9
Black	1.12

*Light reflection efficiency determined by Munsell Color Co., Baltimore.

TABLE 7

The Approximate Reflecting Power to Solar Radiation of Various Colors of Paints Applied on Smooth Surfaces[10]

	Radiation, per cent		Max. B.t.u. absorbed per sq. ft. per hour during Aug. in 40° latitude
Color—	Reflected	Absorbed	
White	84	16	50
Light gray	54	46	143
Aluminum	42	58	180
Black	1	99	307

TABLE 8

Relative Effectiveness of Paints in Keeping Tanks From Warming in the Sun (White Is 90, Black is 0)[20]

	Avg. relative effectiveness as reflector or rejector of heat
Soot	7.5
Black	0.
Red (bright)	17.2
No paint	10.0
Red (dark)	21.3
Aluminum (weathered)	35.5
Gray	47.
Gray (light)	57.
Aluminum	59.2
Aluminum (new)	67.0
Cream or pale blue	72.8
Green (light)	78.5
Gray (glossy)	81.0
Blue (light)	85.
Pink (light)	86.5
Cream (light)	88.5
White	90.
Tin plate	97.5
Mirror or sun shaded	100.

TABLE 9

Approximate Paint Factor Applicable to Various Colored Paints When Computing Predicted Evaporation Loss Caused by Breathing From Atmospheric Fixed-Roof Tanks[12]

	Good paint
Insulation	1.0
White	1.0
Light gray	1.1
Aluminum	1.2
Yellow brown	1.25
Red or black	1.5
No paint	

TABLE 10

Paint Factors Involved in Breathing-Loss Calculations for Gasoline From Cone-Roof Tanks, Shown in the A.P.I. Symposium on Evaporation Loss, November 10, 1952. (Factors Are for Roof and Shell Paint as Stated)[25]

Aluminum, weathered	1.00
White, chalking	0.75
Light gray	1.10
Black, no paint or needs repainting	1.25

White paint provides the best reflection of heat and reduces the evaporation losses to the lowest percentage. It is also of interest, as indicated in some of the tables, that some of the lighter pastel colors such as cream, light yellow, and light blue have reflectivity characteristics which are almost as good as white.

Good reflection . . . Accordingly, a substantial reduction in losses can be achieved by using a paint having good reflection and one which maintains this reflectivity over a long period of time. It is essential that this whiteness must be maintained for a long period, and this is obtained through self-cleansing of the paint by what is best described as "controlled chalking." This quality in a reflective paint will be discussed later at greater length.

The data presented in the first eight tables are, for all practical purposes, summarized in Table 10. Table 10 is a resume presented in an A.P.I. Symposium on Evaporation Loss report in Chicago in 1952. The table, which is applicable to tank shell as well as tank roof, indicates the relative importance which various oil companies place on reflective values for different paints. The table indicates that the use of suitable white paint will reduce breathing losses to 75 per cent of those experienced with aluminum paint and 60 per cent of those experienced with an unpainted roof.

There is no longer any question but that white roofs are a good investment and result in excellent payouts for atmospheric fixed-roof or cone-roof tanks.

2. Conservation-Type Tanks

Whenever conservation tanks are considered, however, a different problem is encountered. These tanks may be considered in two categories for the purposes of this paper:

(a) Variable-vapor-space tanks . . . As the name implies, these tanks—including the wet-seal lifters, the dry-seal lifters, and the flexible-diaphragm tanks—all have a variable-volume vapor space.

(b) Floating-roof tanks . . . The essential difference in operation and evaporation losses in the foregoing two categories is that variable-vapor-space tanks are designed essentially to obtain almost complete elimination of breathing losses but only a slight reduction in throughput or filling losses. Accordingly, they are usually found in those bulk terminals in which the annual turnover is usually less than six times the capacity.

Conversely, floating-roof tanks are designed to eliminate filling losses and do sustain some breathing losses. These tanks are usually found in refineries and large bulk terminals and, in general, will have an annual throughput of 10 or more times the tank capacity. In regard to the color to be used in painting these tanks, it is apparent that, if white paint is used on the variable-vapor-space tanks, there would be a reduction in vapor temperature. Because of their construction, white paint will more effectively reduce vapor temperatures in these tanks than in cone-roof tanks.

Payout . . . Although the saving in breathing loss on these tanks, in spite of the reduced temperature, is not as great as in cone-roof tanks, there is still an attractive payout because of increased capacity and slightly reduced filling losses. Accordingly, it is recommended that a slow-chalking white paint be used for these roofs. On the floating-roof tanks, although white paint would be of some value in reducing breathing losses, it is not recommended because it is impossible to use self-cleansing chalking white paint. This is so because, if such a paint were used, the chalked paint and adhering dirt could not be carried away effectively.

Test Data—Tank Shell

1. Cone-Roof Tanks

Although considerable work has been done over the years on tank-roof paint, no great stress was placed on the color of the shell of the tank, apparently because it was felt that the color of the roof paint was the most important factor affecting evaporation losses. Fur-

ther, inasmuch as the tank-roof area was considerably less than the shell and was more easily repainted, the greater frequency of repainting was not particularly objectionable from a cost standpoint.

In regard to the shell of the tank, it was originally considered advisable to use a dark paint primarily to extend the period between repainting and to avoid erecting expensive staging. The earliest tank-shell colors were black and dark red, and these eventually gave way to shades of gray. Gray was used for many years, although today, to a large extent, it has given way to aluminum paint because aluminum is durable and, except when compared with white, it does have a good solar-heat reflectivity.

White roof and shell . . . Smith and Harden, in a study reported upon at the Products Pipe Line Technology Conference in April 1952,[16] showed that, in their opinion, it was even more important to have the shell white than the roof white and that the greatest effect was obtained by painting both roof and shell white. The apparent reason for this is the extreme difference in the heat conductivity between the liquid phase and the vapor phase.

Further, although an aluminum roof will result in a higher temperature directly under the roof, the heated vapor will act as an insulation keeping the other vapor in the tank relatively cool. In the case of a white roof the vapor directly under the roof is cooled by the convection currents set up by the shell and causes complete mixing, so that the average temperature in the vapor phase is actually higher with a white roof and aluminum shell. The average liquid temperature is several degrees higher for a white roof and aluminum shell than for an aluminum roof and white shell. The majority of the Smith and Harden data was obtained either in drums or relatively small tanks. However, it seems reasonable that the data on the drums and small tanks indicated qualitatively, if not quantitatively, the results which would be obtained in larger storage tanks.

Sidewall transmission . . . Essentially the data showed that energy transmission along a vertical plane, rather than horizontal, accounts for the major portion of the heat energy which is converted to volatile loss from storage. Quoting from Smith and Harden:[16]

"The effectiveness of the sidewall transmission is a function of high heat-transfer coefficients and thermal convection currents, which abet the transfer of available sidewall energy to the two phases of gasoline. This absorption of sidewall energy reduces the stratification of heavy hydrocarbon vapors near the liquid vapor interface and augments the natural breathing and venting of the tank by the constant readjustment of the liquid's effective vapor pressure. In contrast, the transfer of energy downward from the roof area primarily affects only the thermal expansion characteristics of the vapor, and tends to be self-insulating."

A special report was made in The Oil and Gas Journal, July 14, 1952.[22] Although the presentation is somewhat different, the conclusions are exactly the same. This article also points out that, in their small-scale tests, the liquid phase absorbs 120 times the available energy absorbed in the vapor space, despite the fact that 60 per cent of the tank surface area is in contact with the vapor space. This relationship would undoubtedly be changed in favor of the vapor space if the normal relationship of diameter to height were used, and if the tests were conducted on a year-round basis instead of just for 1 or 2 months.

Large tanks . . . It was realized that, in order to get the proper quantitive facts, large tanks would have to be used and, accordingly, additional test work was done in two newly painted 80,000-bbl. cone-roof tanks, one painted aluminum and the other white. Both tanks were half full of 10.5-lb.-R.v.p. motor gasoline. This study was completed in the early fall and again proved that the evaporation losses were proportional to the amount of solar energy absorbed by the liquid and vapor phases of the storage product. The data on this test are given in Table 1.

It was concluded that the transmission of energy responsible for evaporation losses is primarily through the shell of a storage tank.

Costs . . . On these large 80,000-bbl. tanks, a conservative estimate of additional losses (aluminum over white) was $1,750 per year for motor gasoline. If it is assumed that white paint has half the life of aluminum paint, which is a conservative estimate, and that repainting of white must proceed every 3 years, the cost of an extra coat of white paint every 3 years can be assessed over a 6-year period based on 5 cents per square foot for repainting costs. The additional cost of repainting based on a 120 by 40-ft. 80,000-bbl. tank at 5 cents per square foot is $1,320, or $220 per year. Accordingly, for a gross saving of $1,750 per year, there is a net saving after deducting additional paint costs of $1,530 per year, and a figure of $1,500 would seem conservative. The gasoline savings quoted are from the Smith and Harden article,[22] but the data on repainting costs were arrived at independently and constitute our own data presented later in this paper.

White vs. aluminum . . . The conclusions reached by the American Petroleum Institute at the Symposium on Evaporation Loss previously quoted (see Table 10) are that evaporation losses are reduced 25 per cent provided that the roof and shell of cone-roof tanks are painted white rather than aluminum. Based on the data presented in this paper, the author feels that this is a reasonable conclusion, although for reasons cited later, it may be that the savings would be in the range of 20 to 30 per cent rather than the 25 per cent figure actually used. Another slight advantage in favor of having an all white cone-roof tank is that staining of the shell of the tank, previously noticed with a white roof and an aluminum or gray shell particularly on tanks having inside top angles, will no longer be observed.

Crude-oil volatility . . . The storage of crude oil in cone-roof tanks presents a special problem. If it is assumed that the quality of the crude oil purchased is approximately average, then the color of the cone-roof tank depends on the volatility of the crude oil. Although the following figure represents at best an approximation, depending on ambient temperature and other factors, a Reid vapor pressure of 4.0 lb. is a reasonable estimate of the point of division; crude oils with a Reid vapor pressure of 4.0 lb. or above should be stored in cone-roof tanks painted white, although the paint color is not significant in the case of crude oils with lower Reid vapor pressure.

It will be difficult to arrive at exact savings on the value of white shell paint in cone-roof tanks storing volatile products unless the following factors, which refer to the Smith and Harden article,[22] are given consideration:

(a) No data are given concerning the area of the roof as compared to the height of the tank. In a survey of hundreds of tanks it was proved that only 23 per cent of the total area was roof. Obviously, a tall tank would lend itself to greater heat absorption through the sides, whereas a large, low-framed cone-roof tank would transfer proportionately more heat through the roof.

(b) Inasmuch as the work was done on a 50 per cent capacity basis, the relatively large vapor phase would present a greater insulating barrier to heat transfer than when the liquid phase increased.

(c) There is no indication that any of the tanks which were tested and reported on in the article were working tanks. It can be assumed that, in work-

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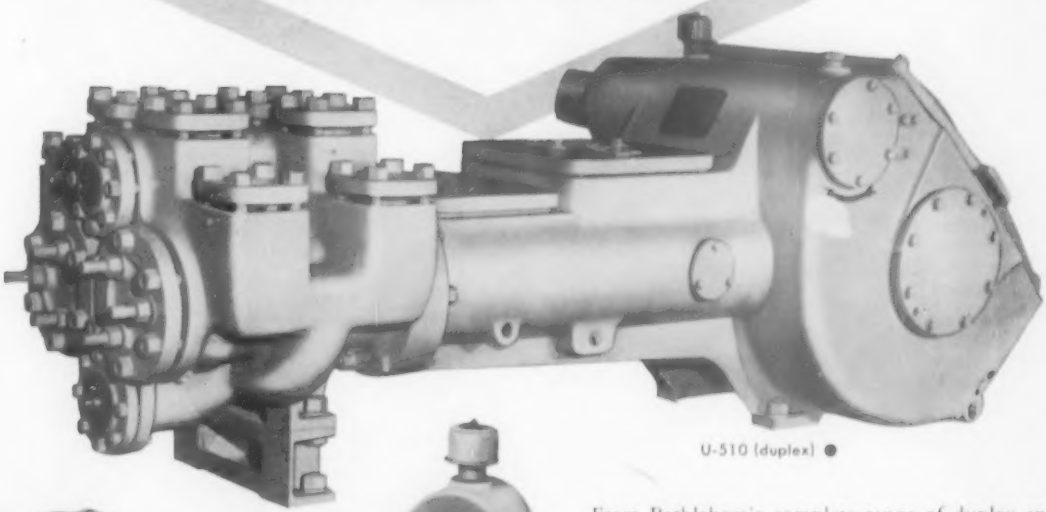

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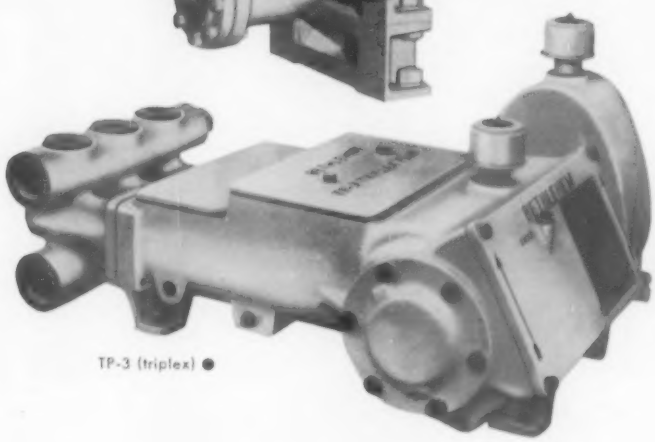

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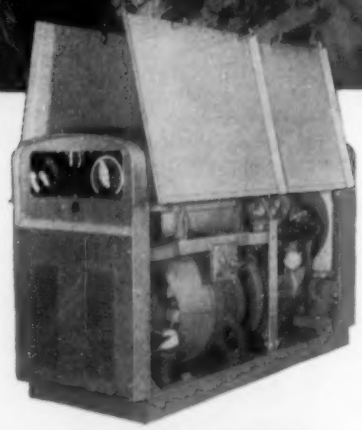

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ing tanks, blending of fresh stocks maintain liquid temperature more nearly constant, thereby permitting less influence on the liquid phase by heat transfer through the sides.

(d) The picture has apparently been developed for product storage in temperature climates. It is conceivable that in tropical or semitropical areas, the greater amount of vertical solar radiation would enhance the importance of white roofs and decrease the relative importance of white side walls. Moreover, a corrosive atmosphere could modify the conclusion by its effect on paint life.

2. Conservation-Type Tanks

On the variable-vapor-space tanks previously mentioned, it is believed that present data do not warrant slow-chalking white paint from an evaporation-loss standpoint. The recommended white roof paint, covering a somewhat larger area than on a similar cone-roof tank, is more effective than in the case of the cone-roof tank; and, accordingly, additional savings in breathing losses from shell paint may be disregarded. White shell paint would probably reduce throughput or filling losses slightly because of lower product temperatures, but not nearly enough to warrant the increased cost of painting with white paint.

The floating-roof tanks present a different problem and should be considered in two categories insofar as shell paint is concerned:

(a) Old floating-roof tanks or tanks with riveted shells.

(b) Newer or welded floating-roof tanks.

Older floating-roof tanks . . . Breathing losses are a matter of some concern particularly when the tank is known to be out-of-round or equipped with a pan-type roof. Losses by breathing in tanks of this nature may exceed those in a cone-roof tank. The potential breathing-loss savings on riveted-shell floating-roof tanks are sufficiently great that a slow-chalking white paint is recommended for the shell. Where crude oil is stored in older floating-roof tanks, each case must be considered on its own merits.

Newer floating-roof tanks . . . For these, including only tanks equipped with welded shells and particularly those having double decks or special devices to minimize breathing losses, white shell paint is not recommended. The reason for this is that breathing losses are only a friction of those sustained by the comparable cone-roof tank and, accordingly, potential savings are too small to warrant the additional cost of white paint. Obviously, in both categories of floating-roof tanks there will be some tanks of doubtful classification insofar as breathing loss is concerned. The exact status of these tanks should be determined by a careful inspection of the tank roof, and a careful appraisal made as to the probable breathing losses. If this survey has been made, it will then be possible to recommend the color of paint to be applied to the shell.

Paint—Type, Methods and Costs of Application

1. Color

As has previously been indicated, the most reflective paint is the white paint, and the exact type of white paint will be described subsequently in greater detail. However, in connection with color you are no doubt aware of the recent trend in oil refineries and marketing terminals toward the use of many colored paints, particularly the pastel shades.

Eye appeal . . . A major oil company has started a program aimed at improving the eye appeal of its tankage. At a large eastern refinery the shells of many tanks have been painted in pastel colors and, in some cases, the tanks have been painted with two contrasting colors. There are several reasons for this: One is that oil storage tanks are classified by the average motorist as unsightly, and it is hoped that the pastel shades will be more pleasing to the eye and promote better public relations. Another reason is that these pastel colors may have a psychological value as a morale booster insofar as the refinery worker is concerned. This program has also been extended to some of the company's marketing terminals.

Two-tone? . . . In the case of the refinery tanks there are two color schemes which have been used. In some cases the entire shell has a pastel color whereas, in other cases, a two-tone effect is used involving a dark color on the lower half of the tank and a light color on the upper half. For example, if the lower half is blue, the upper half could be yellow; or the lower half red, and the upper half pink. Some tanks have a solid shell color with a top band or red or blue. Apparently the interest is more in color contrast than it is in a tank with a solid color on the shell.

As shown in the tables the temperature rise of both vapor and liquid is greater in tanks painted with a color than with a tank painted white. However, it is possible to use a two-tone pastel color combination and still not lose too much from an evaporation-loss standpoint. For example, if the roof is painted white and the shell is painted cream or light yellow, light blue, or light pink, the reflective value of the paint on the shell will be greater than aluminum or gray and, in fact, inferior only to white. Although this would result in a slightly greater loss of volatile products by evaporation than for white paint, this loss would not be great and would be more than counterbalanced by the aesthetic appeal and the improvement in morale. Although these latter factors cannot readily be evaluated in terms of dollars and cents, it is believed in many quarters that they are worth this slight additional expense.

Tinted aluminum . . . Our own company has experimented with tinted aluminum paint for some time. Do not confuse tinted aluminum with the blue tint added to the first coat of a two-coat aluminum paint job to insure complete coverage of the top coat. These tinted products are for the purpose of adding color to the final aluminum coat. Most of the original experiments were confined to small tanks and test panels to determine the weathering characteristics and permanency of the various colors. Inasmuch as aluminum paint is not recommended for evaporation-loss purposes, as indicated in Table 10, it is obvious that the tinted paint is also not recommended for volatile-product tanks as, for all practical purposes, it has the same reflective value as the base aluminum.

Shell specifications . . . Although aluminum is not recommended for tank shells, it is true that, in many cases, present specifications on volatile-product tanks still indicate white roof coats and aluminum shell coats. The author believes that ultimately most shell specifications on volatile-product tanks will call for white paint. However, pending this time, it should be noted that a diffuse type of ready-mixed aluminum paint is the recommended type. In this paint there is a certain roughness which deflects the sun's rays in all directions, thus providing maximum reflective characteristics. A smooth-surfaced aluminum paint, after weathering, has a tendency to appear dull gray and to reflect the sun's rays from only one angle. The diffuse type of aluminum paint is recommended for shells of volatile-product tanks only where it is essential that aluminum be used in order to comply with present specifications.

2. Type

It has been established in the foregoing that white is the most efficient pigment which can be used for high solar reflectivity and consequent minimization of evaporation losses. The ideal white paint for this purpose should

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not only have a high degree of whiteness, but it should have the ability to maintain this whiteness. Also, it should have a high degree of permanence. This paint will most effectively reduce tank temperatures and show the lowest evaporation loss over the longest practical period of time. A satisfactory tank white paint should:

(a) Provide high solar reflectance during the entire life of the film.

(b) Provide long life and protection against severe weathering and corrosive refinery or other industrial fumes.

Pigment . . . The quality of whiteness is obtained from the pigment. The ideal paint for storage tanks is one in which the pigment particles are packed closely together. This close-packed pattern results in a paint film which has good resistance to soiling and dirt pickup. The preferred pigment is titanium dioxide, which has the highest whiteness of any pigment and is also chemically inert.

It is an established fact that stone, glass, concrete, composition shingles, and the like collect dirt and become dingy and, in industrial areas, become actually black in appearance. In other words, all surfaces which are relatively permanent in nature and show little or no surface decomposition become dirty and unsightly. Paints are no different from other materials in this respect; as their durability is increased and the rate of surface failure retarded, their tendency to collect dirt increases. When paint soils, its reflective quality approaches that of the adherent dirt film, which is invariably lower than that of the white finish. Therefore, an acceptable tank white paint must be self-cleansing. In the chalking process an extremely fine white powder forms on the surface, which is washed off by rain and wind taking along with it the heat-absorbing grime and dirt.

The vehicle itself adds nothing to whiteness, but acts as a binder for the pigment and bonds the paint to the surface. In this regard, the most durable vehicle for paints is still an alkyd resin or modified glyceryl phthalate. Inasmuch as the vehicle collects and holds dust and may even discolor, the proportion of vehicle in the paint should be low and the quantity—and continuity—of pigment in the dried paint film high.

Brightness vs. permanence . . . There is apparent conflict in two desired properties of paint, viz., the ability to maintain brightness and the degree of permanence. Brightness is maintained by suitable composition and proportion of vehicle and pigment, so that a slow and controlled chalking results. A satisfactory paint is designed to delay initial chalking as long as possible for the particular environment to which the tank is exposed. In this manner, the paint remains self-cleansing and yet has reasonably good life.

The rate of surface renewal required to maintain a good brightness on the tank roof will vary with the environment. Whenever terminals are located near chemical plants or in an industrial area, or are subjected to smoke or the effect of fumes and dirt, a comparatively free-chalking special white paint is required. On the other hand, for the vast majority of storage terminals, a slower-chalking and consequently more durable white has proved satisfactory.

3. Frequency of Repainting

Storage tanks containing volatile products are painted not only to reduce evaporation and improve their appearance, but also to counteract the effect of corrosion which shortens the useful life of the tank. It has been estimated that over 1,000,000 gal. of paint are consumed every 3 days for corrosion prevention of steel. Much of this quantity is used for this purpose by the petroleum industry. In fact, protection from corrosion and reduced evaporation of products constitute the two most important reasons for application of paint to storage tanks.

In combating corrosion, paint functions principally by means of the following two methods:

(a) By sealing off the steel surface from the corrosive environment, i.e., waterproofing and exclusion of oxygen.

(b) By pigmentations which alter conditions favoring corrosion, i.e., prevent transmission of electrolytic currents.

It is not the function of this paper to discuss the problem of arresting corrosion, but it has been mentioned here because corrosion and reduction of evaporation losses are the two major reasons for the application of paint to volatile-product tanks. Experiments are presently under way on painting the interior bottom ring of storage tanks in an effort to minimize corrosion.

The frequency of repainting is dependent upon a variety of factors. With careful surface preparation and application, some paints have performed satisfactorily for 10 to 15 years, according to a report made by Humble Oil & Refining Co.; whereas, in corrosive areas, the life of paint has been restricted to 3 to 6 years.

Proper surface treatment . . . Magnolia Petroleum Co. has proved that selection of the proper surface treatment is vital to success of the painting job. Magnolia treated four sections of a tank roof with various preparations. After 20 months one section still had an excellent surface coat although others had failed. This section had been pretreated with a special penetrating-oil preparation which assured the necessary bond.

Data have been obtained in a typical eastern marketing area in our own company which indicate that the average period between repainting storage tanks is 3 to 4 years for white roofs and 5 years for aluminum paint on the tank shells. Another area reports a somewhat longer average life of aluminum shell paint, varying from 5 to 10 years depending upon the location of the terminal; i.e., close to salt water or industrial locations on the one hand, or located inland on the other. In this former area special attention is paid to the problem of repainting. In regard to the relative life of white and aluminum, a well-formulated slow-chalking white should give 4 to 5 years' life on the shell provided that the life of aluminum is known to be 6 years.

4. Cost of Materials and Labor

In analyzing painting costs it is essential to realize that labor costs constitute approximately 80 per cent of the total costs. Accordingly, it is good policy to use the most suitable paint, even if the paint cost is somewhat higher.

Three methods . . . On methods of paint application to storage tanks, the oil industry generally has used three methods, viz., brush, spray, and roller. A brief discussion of these methods is warranted. Brush painting is the oldest and slowest method, and the application is not usually uniform from one painter to another. This method is relatively costly and old-fashioned, and is not recommended.

Spray painting, which has been used to a considerable extent in the past few years, is easy and much faster than brushing, but is no longer preferred for the following reasons:

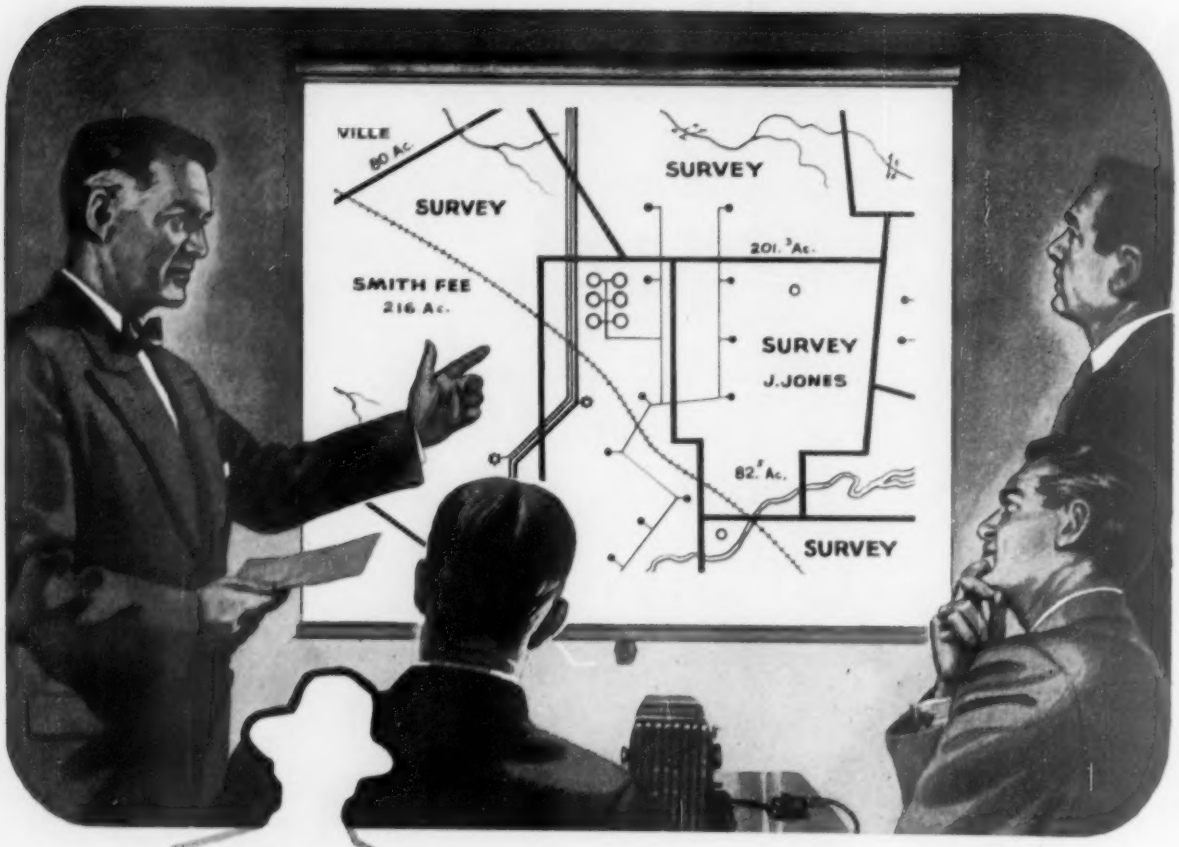
(a) Paint may be blown from tank and cause damage by spattering on parked automobiles and adjacent building.

(b) Spray painting requires the painter to wear a face mask which is objectionable.

(c) The application of spray paint varies with the technique used by the individual painter.

Present developments indicate that a long nap roller, the most recent equipment, is the best method of paint application and is the most economical in regard to labor costs. Further, painting by roller usually results in a more uniform application. In the case of my own company, the use of a long nap roller is the recommended method for storage tanks.

Repainting costs . . . The cost of re-



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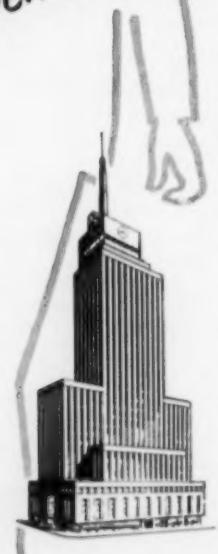

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painting tanks will vary depending upon the size of the tank and the size of the job, whether or not spot priming is included, and the number of finish coats. In Socony Mobil, available data indicate that, for spot priming and one finish coat, a cost of 5 cents per square foot, including labor and material, may be used for both roof and shell. Obviously this is an average figure and should not be used indiscriminately. With reference to original painting of a new tank, if it is assumed that the tank is to be sandblasted, given two primer coats and then two finish coats, an approximate cost would be 15 to 18 cents per square foot, including labor and materials. It is of some interest to note that the prices quoted either for repainting or for the original application are identical regardless of whether the color of the paint is white, aluminum, gray, or pastel. If the price is quoted on a contract basis, apparently it makes little difference whether a spray or roller type of application is used.

Data Summary

The accompanying tables were taken from the literature as indicated, and portray some of the variations in reflective qualities of different paints as reported by the various investigators.

Although these tables show considerable similarity, there is, of course, a difference in the individual results and, for this reason, we have listed also Table 10, which, in our opinion, represents an effective summary. Table 10 was obtained from the A.P.I. Symposium on Evaporation Loss held in Chicago, November 1952.

Acknowledgment

The writer wishes to express his appreciation to Dr. P. L. Lotz, of Socony Paint Products Co., for his invaluable technical assistance in the preparation of this paper.

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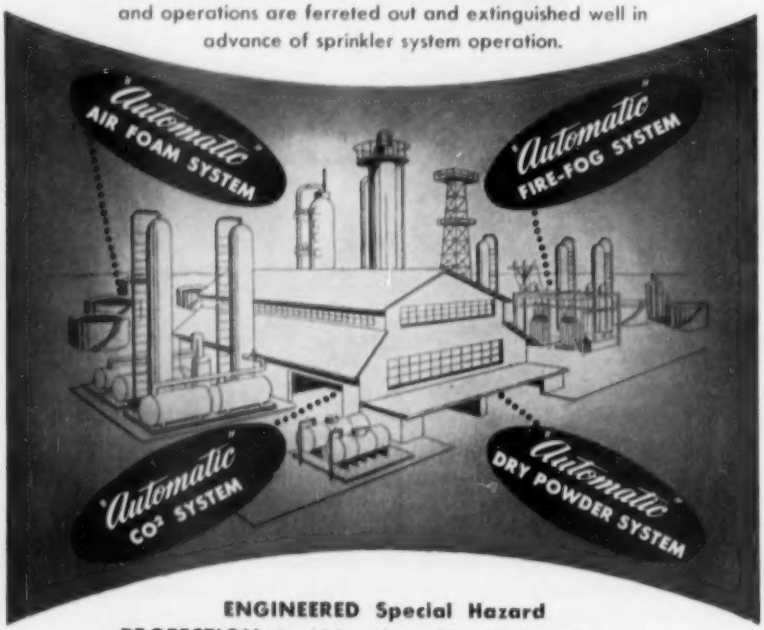

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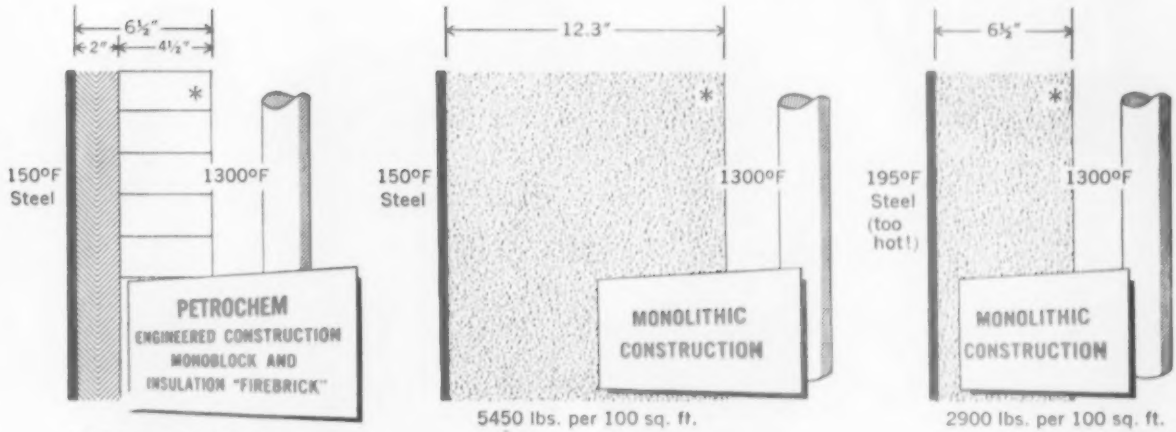

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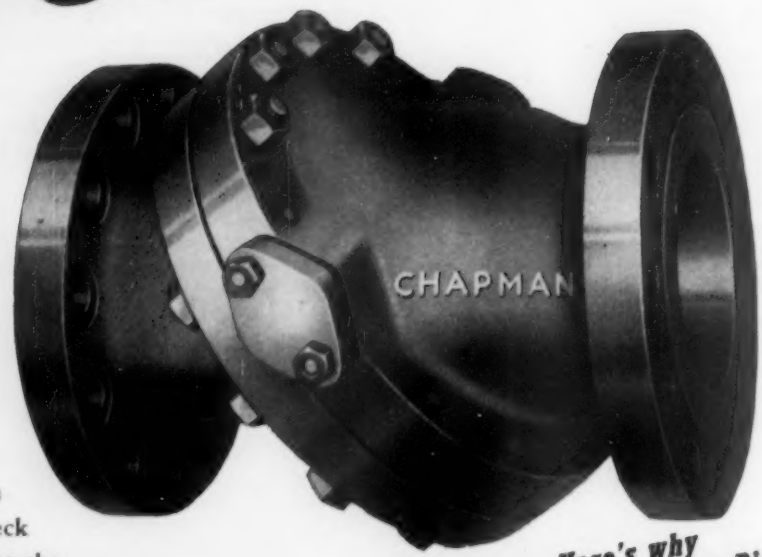
Only Chapman Tilting Disc Check Valves give you

FAST TIGHT QUIET CLOSURE



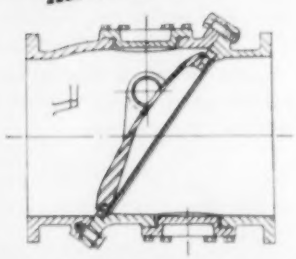
Fast, quiet operation means low cost operation for check valves. That's exactly what the Chapman Tilting Disc Check Valve is designed to do. It won't flutter or slam and damage the piping joints or the valve itself. The unique drop-tight closure action eliminates scraping and wear of the disc and seat.

Rugged construction and low wear of the Chapman Tilting Disc Check Valves mean long life under severe operating conditions. Absence of vibration plus low head loss keep maintenance of the entire piping system at a minimum.

Whether for replacement or for new piping systems, be sure to specify Chapman Tilting Disc Check Valves. They're available in iron and steel for handling fluids or gases under a wide range of pressures. For full data on the complete line, write today. Ask for Catalog 30-A.

The Chapman Valve Mfg. Co.
INDIAN ORCHARD, MASSACHUSETTS

Here's why Chapman's Tilting Disc Check Valves Keep Quiet All of Their Lives



This specially designed "airfoil" disc balances perfectly in open position. The fluid holds the disc tightly against its stops without flutter. The body of the valve is larger around the disc, so the net valve area is at least as much as the pipe area to assure low flow resistance.

When the flow is reversed, pressure against the upper part of the disc cushions it as it closes. Then the disc drops easily and tightly to its beveled seat after the valve has swung closed. Seating is fast and quiet with minimum head loss in all but unusual piping arrangements.

by W. L. Nelson
Technical Editor

COST-imating

2. Quick Costs for Heat Exchangers

THE figure on this page shows the 1946 surface cost of the most conventional type of heat exchanger, namely:

Internal floating head
150 psig.
Steel tubes with iron shell
16 ft. tube length
⅝-in. tubes
Useful to 650° F.

These basic costs can be converted to the cost at other years by the Indexes shown on this page and to current dates by the Exchanger Indexes published in connection with the Nelson Refinery Construction Cost Index which is published in the first issue each month of The Oil and Gas Journal. Likewise, factors (multipliers) are shown on this page for the effect of type of construction, pressure, temperature, materials of construction, tube length, etc.

Example . . . A 1,200-sq.-ft. internal floating head exchanger with an expansion ring in the shell has brass tubes and sheets, a 12-ft. tube length, ⅝-in. tubes, and is to operate at a maximum of 75 psig. in the shell. The basic 1946 cost is $2.80 per sq. ft. (see figure). Corrections for the expansion ring, brass construction, tube length and pressure result in the following per-square-foot cost (1946):

$2.80 × 1.05 × 1.24 × 1.1 × 0.94 = $3.76

The total cost during 1955 is about:

$3.76 × 1.57 × 1200 = $7,100

FACTORS FOR MATERIALS[4,9,10]

Steel sheet and tubes	**1.00**
Brass bundle	1.13-1.38*
Aluminum bundle and channel	1.09-1.14
80:20 Cupro nickel bundle	1.5-1.75
406 Chrome bundle	1.50-2.64
304 stainless bundle	2.20-3.40
304 stainless tubes only	1.8-2.5
316 stainless tubes only	2.2-2.4
18-8 tubes, lined channel	2.0-3.0
18-8 tubes, lined channel and clad shell	4.0-6.0
18-8 clad shell only	5.5-7.0
18-8 solid shell only	8.0-9.0
406 chrome shell only	4.5-6.0

*Varies widely with the price of copper.

TUBE DIAMETER[5]

½ in.	0.93
⅝ in.	**1.0**
¾ in.	1.03
1 in.	1.1
1¼ in.	1.3
1½ in.	1.5

COST INDEXES (1946 = 100)[1,2]

	Exchangers	Labor	Nelson index
1946	100	100	100.0
1947	115	113	117.0
1948	130	128	132.5
1949	133	137	139.7
1950	140	144	146.2
1951	152	152	157.2
1952	166	163	163.6
1953	175	174	173.5
1954	174	183	179.8
1955 est.	157	190	184.5

FACTORS FOR TYPE OF CONSTRUCTION[1,4,5]

Tubes only	0.06-0.27
Bundle only	0.3-0.6
Shell (all but bundle)	0.73-0.94
Fixed head	0.5-0.82
Nonremovable bundle	0.5-0.7
Clamp-ring construction	0.9-1.0
Internal floating head	**1.0**
Reboilers (Kettle type)	0.88-1.2
Expansion ring in shell	1.0-1.1
External floating head	1.1-1.2
Vacuum (wide tube spacing)	1.3-1.4
Tank suction heaters	0.35-0.65

FACTORS FOR PRESSURE (and temperature)[1,4,6,8]

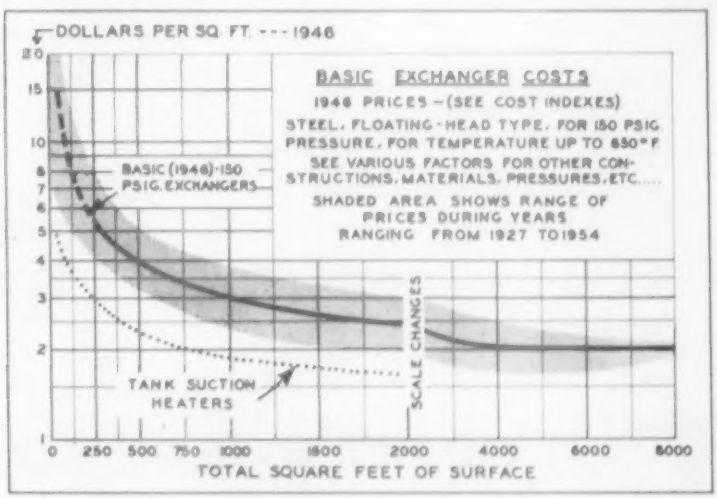
75 psig.	0.94
150 psig.	**1.00**
300 psig.	1.10
450 psig.	1.22
600 psig.	1.36
900 psig.	1.75
1200 psig.	1.90
1800 psig.	2.45
2500 psig.	3.15
5000 psig.	6.60
650-900° F.	1.08

FACTORS FOR TUBE LENGTH[1,5]

6 ft.	1.3 -1.4
12 ft.	1.07-1.1
12 ft.	**1.0**
20 ft.	0.95-0.97
24 ft.	0.93-0.96

INSTALLATION COSTS[1,3]

Per cent of material cost	5-10
Per shell: on ground, small	$100
on ground, large	$150
Above ground (or condensers)	$225
Insulation: per sq. ft. shell	$0.60-1.60
Foundations: cu. yd. concrete	
500 sq. ft.	1.7
1,000 sq. ft.	2.3
3,000 sq. ft.	3.8
Tramrails: lb. structural steel	
10,000 lb. bundle	1,000-1,400 lb.
40,000 lb. bundle	1,900-2,600 lb.



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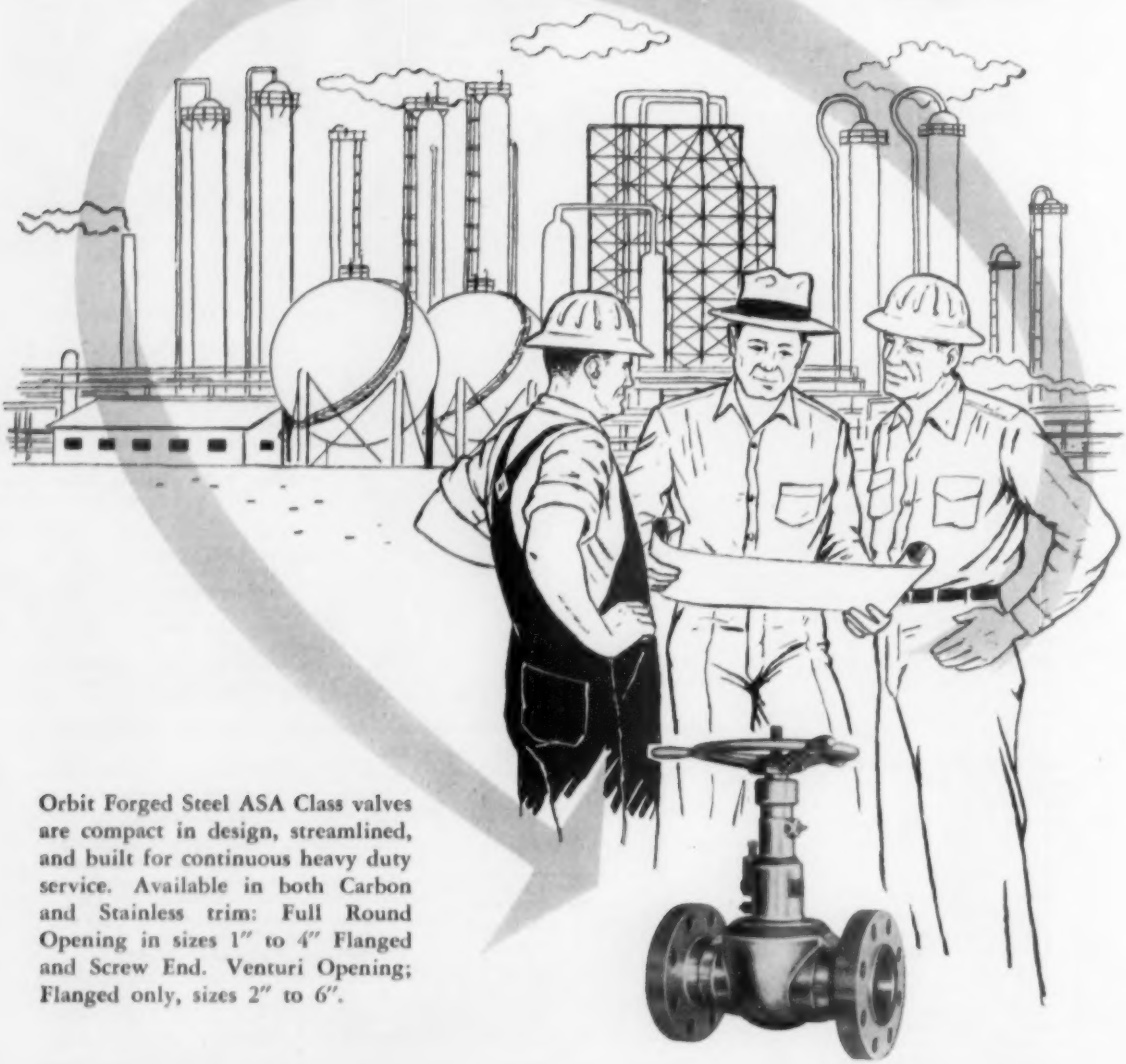

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by Ovid Baker
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CALCULATION OF SURFACE TENSION—1

Here's What Surface Tension Is

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SURFACE tension is an important property where wetting, penetrating, foaming or droplet formation of a liquid is considered. Surface-tension values are needed in equations used in the design of fractionators, absorbers, separators, reboilers, two-phase pipelines, and in reservoir calculations.

What it is . . . A molecule in the interior of a liquid is completely surrounded by other molecules and is attracted equally in all directions. On a molecule in the surface, however, there is a resultant attraction inward because the number of molecules per unit volume is greater in the bulk of the liquid than in the vapor.[10 11 12 13]

As a result of this inward pull, the surface of the liquid tends to adjust itself to the minimum surface area, causing droplets and bubbles to assume a spherical shape. To extend the area of the surface, it is obviously necessary to do work to bring the molecules from the bulk of the liquid into the surface against the inward attractive force.

The work required to increase the area by 1 sq. cm. is called the free surface energy. It is expressed in ergs per square centimeter. The attractive force may be thought of as an elastic film over the liquid surface, the tension of which causes the surface to contract to the smallest possible area for the volume of the liquid. It is possible to assign a value to this surface tension expressed as dynes per centimeter.

Units and Conversion Factors

Work = force × distance or,
Ergs = dynes × centimeters.

To create 1 sq. cm. of new liquid surface, the work done is expressed in ergs per square centimeter.

$$\frac{\text{ergs}}{\text{cm.}^2} = \frac{\text{dynes} \times \text{cm.}}{\text{cm.}^2}$$

$$\frac{\text{ergs}}{\text{cm.}^2} = \frac{\text{dynes}}{\text{cm.}}$$

To convert to English units:

(Dynes /cm.) (6.8523×10^{-5}) = lb./ft.
(Dynes) (2.248×10^{-6}) = lb.
(Ergs) (3.722×10^{-14}) = hp.-hr.
(Ergs) (7.376×10^{-8}) = ft.-lb.
(Ergs/cm.^{2}) (6.8523×10^{-5}) = ft.-lb./sq. ft.
(Ergs/cm.^{2}) (3.4607×10^{-11}) = hp.-hr./sq. ft.

Authors are with natural-gas department, Magnolia Petroleum Co., Box 900, Dallas 21.

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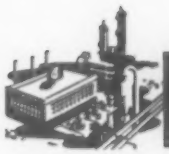

JOB IMPROVEMENT FOR THE PROCESS FOREMAN—31

Points to Consider in Selecting a Rotary Pump

THE pumping action of all rotary pumps is essentially the same. As the pumping elements are rotated, they open on the inlet side, and create a void. The fluid, forced by atmospheric pressure, flows in to fill this space.

The continued turning of the rotors encloses the fluid between the rotating parts themselves, or between these parts and pump casing. At this point, the rotating parts are under inlet pressure and continue so until the enclosed portions open into the outlet chamber.

Q. How do you find a pump's delivered or net capacity?

A. Since the pump is a positive-displacement device, every revolution of the shaft lets a definite quantity of fluid pass through. If no clearance existed, this quantity (called "theoretical capacity") would be dependent only on the speed and the physical dimensions of the pumping elements.

But clearances do exist, so whenever a pressure differential occurs, there will always be internal leakage from the outlet side to the inlet side.

This leakage (usually called "slip") may be relatively large or small depending on the type of pump, the amount of clearance, the viscosity of the fluid handled, and the differential between outlet and inlet pressures.

For any given set of conditions, it is not usually affected by speed. The delivered or net capacity, therefore, is the theoretical capacity less slippage.

The theoretical capacity of any pump can be readily calculated if all the essential dimensions are known. Slip can likewise be calculated, but is usually based on empirical values developed as a result of tests. This data is a part of the stock in trade of every pump manufacturer, and capacities can be accurately predicted for any given set of conditions.

Q. What are some basic factors to consider in selecting a rotary pump?

A. This is not difficult if all the operating conditions are known. Since a rotary pump is a positive displacement device, such operating conditions as inlet conditions and viscosity are important factors. In fact, they are just as important in the selection of rotary pumps as they are for other pumps.

In any rotary-pump application, suction lift, viscosity, and speed are inseparable. To insure quiet, efficient operation it is necessary to completely fill the compartments in the pumping elements with fluid as they open. This becomes more difficult as viscosity or suction lift increases.

Basically, once the fluid reaches the pumping elements, discharging it poses no serious problem. The real problems are on the suction side of the pump—getting the fluid in.

Speed of operation, therefore, is dependent on viscosity and suction lift. If these two factors are known, the problem of selecting a suitable pump becomes infinitely simpler and an efficient installation can be insured.

Q. Where does viscosity enter into rotary pump selection?

A. It is not very often that a rotary pump is called upon to handle fluids of constant viscosity. Normally, temperature variations produce a range of viscosity. It is not unusual for a pump to be required to handle a fluid with a viscosity range of 10 to 20,000 S.U.s.; the higher viscosity is usually due to cold starting conditions. This is a perfectly satisfactory range for a rotary pump.

However, a better selection can be made if information can be obtained concerning such factors as the amount of time the pump is required to operate at the higher viscosity and whether the motor can be overloaded temporarily, a multi-speed motor can be used, or the discharge pressure can be reduced during this period.

Quite often no viscosity is given—only the type of fluid. In such cases, assumptions can sometimes be made if enough information is available concerning the fluid. For instance, Bunker C or No. 6 fuel oil is known to have a wide viscosity range and usually must be handled over a considerable temperature range. The normal procedure in a case of this type is to assume an operating viscosity range of 20 to 70 S.F.s.

The maximum viscosity, however, might very easily exceed the higher value if extra-heavy oil is used or exceptionally low temperatures are encountered. If either should occur, the result may be improper filling of the pumping elements, noisy operation, and overloading of the motor.

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Among the Drilling Contractors

Contractors Stress Value Of Good Chapter Meetings

Officers of the American Association of Oilwell Drilling Contractors, and chairmen, or representatives, of its various chapters over the country, in a special meeting at association headquarters in Dallas, emphasized the importance of planning interesting chapter meetings which are well publicized and tailored to local needs and interests.

The meeting was called by E. Dale Mount, of Dallas, recently elected association president, to consider association and chapter policies for the year.

Association officers present, in addition to Mount, were: Brad Mills, executive vice president; W. L. McClusky, secretary-treasurer; and Marion S. Church, general counsel, all of Dallas; and vice presidents: Jack H. Abernathy, Oklahoma City; M. M. Brantly, Midland, Tex.; A. H. Crawford, Shreveport; H. W. Davidson, Midland; W. C. Fatjo, Lafayette, La.; D. B. Ferguson, Oklahoma City; John J. Moran, Wichita Falls, Tex.; George H. Pappas, Mount Carmel, Ill.; Ray A Sing, Casper, Wyo.; S. I. Williams, Los Angeles.

Chapter chairmen present were: Jack L. Cox, Wichita Falls; Gerald N. Eason, Oklahoma City; H. P. Goodrich, Midland, Tex.; Mark L. Hart, Fort Worth; George D. Hunter, Abilene, Tex.; Baker R. Littlefield, Lafayette, La.; Morris McDannald, Houston; Austin W. Mosley, San Antonio; Bob Persful, Shreveport; Charles M. Powell, Jr., Wichita; R. C. Sharp, Los Angeles; and Don Slape, Olney, Ill. Guy E. Keith, chairman at Casper, Wyo., was represented by Tom LaMore; and T. W. Wheeler, Tulsa, by M. D. McBride.

Iraq Drilling Co., Longview, Tex., has scheduled a 5,500-ft. test to be drilled for Bobby Manziel at a wildcat location, 2 Ault et al, in the James Ferguson Survey, 4½ miles southeast of Jacksonville, in Cherokee County, East Texas.

Paul Rutledge, Santa Fe, N. M., is contractor on a new wildcat operation Phillips Petroleum Co. and R. M. Ballard are undertaking 5 miles north of Noonan, in eastern Divide County, in the northwestern corner of North Dakota. Location, in 29-162n-95w, is 12 miles from the Canadian border.

Dallas Contractor Orders Barge for Offshore Work

Southeastern Drilling Co., of Dallas, has awarded contracts for the construction of a self-stabilizing, submersible, elevated-deck, drilling-barge unit for offshore operations in the Gulf of Mexico. It will be Southeastern's first marine assembly.

The barge unit, designed by Frede & Goldman, Inc., naval architects and marine engineers, of New Orleans, and being built by Avondale Marine Ways, Inc., will be similar to others now in use by other companies.

It will be capable of operation in open-sea water 25 ft. deep, and in deeper, more protected water nearer shore.

The unit will consist essentially of a slotted hull with an elevated drilling deck supported by fixed columns. Lowering and raising of the hull will be effected hydraulically with stability maintained by four bottom-nested pontoons, actuated by hydraulically operated rams. It will support all necessary

John Hagestad (right), president of Hagestad Drilling Co., Bakersfield, Calif., receives the 1954 safety award (bronze plaque) presented by George Churchill, representative of Employers Mutuals of Wausau, at the company's recent quarterly safety dinner. The award is in recognition of the safety record established by the drilling crew on Hagestad's Rig. No. 3, on which Ken Neumeyer is tool pusher.

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Bush Drilling Co., Eunice, La., has taken on a 9,500-ft. job in Allen Parish, southern Louisiana. It is a wildcat test for F. E. Jameson, of Beaumont, Tex., at 1 Sidney LeBlanc, in 11-6s-6w, about 6 miles north of Kinder field.

H. L. Edwards Drilling Co., Houston, has a new wildcat operation in Iberia Parish, Coastal Louisiana. It is a contract job, projected to 13,000 ft., for Austral Oil Exploration Co. on Little Lake Long prospect, 2½ miles southwest of Lake Chichot field. Designation is 1 Bauer, in 1-12s-9e.

Falcon Seaboard Drilling Co., Tulsa, will drill a 14,000-ft. test for Tide Water Associated Oil Co. northwest of production in the Erath area, Vermilion Parish, Coastal Louisiana. Location is at 1 Rose, in 40-R13s-4e.

K. L. Kellogg & Sons, Compton, Calif., is drilling Sunray Mid-Continent Oil Co.'s deep test in the Tejon Flats area, 20 miles southeast of Bakersfield, in South Central Kern County, southern California. The test, 23-11 Tejon, in 11-11n-19w, is expected to be carried to the basement about 12,000 ft. It is 1¼ miles southeast of a 11,963-ft. dry hole drilled last year by General Petroleum Corp.

Green & Heiser Drilling Co., Bakersfield, Calif., has moved a rig to the Midway-Sunset area, 10 miles west of McKittrick, on the west of San Joaquin Valley, Kern County, California, where it is under contract to Oceanic Oil Co. in the latter's deeper exploratory drilling program. Oceanic has two other contract rigs in the area, one operated by **Casner & Bentz,** of Oildale, and the other by **B. J. & M. Drilling Co.,** of Los Angeles.

D & D Drilling Co., Casper, is drilling at a wildcat location on the southwest side of the Teapot Dome area, 30 miles north of Casper, in Natrona County, Wyoming. It is a contract job for Edwin Snyder at 1 Government, in 29-39n-78w.

Horace Coon is contractor on a 6,500-ft. wildcat test being drilled for C. G. Dunwoody, Jr., 10 miles northeast of Campbellton, in Aatscosa County, Southwest Texas. Location is at 1 Bryan Campbell, in the Jose M. Sanchez Survey.

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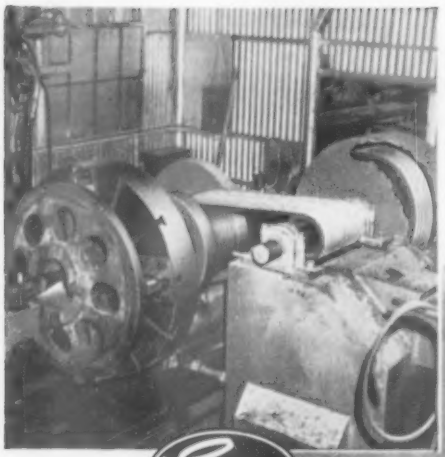
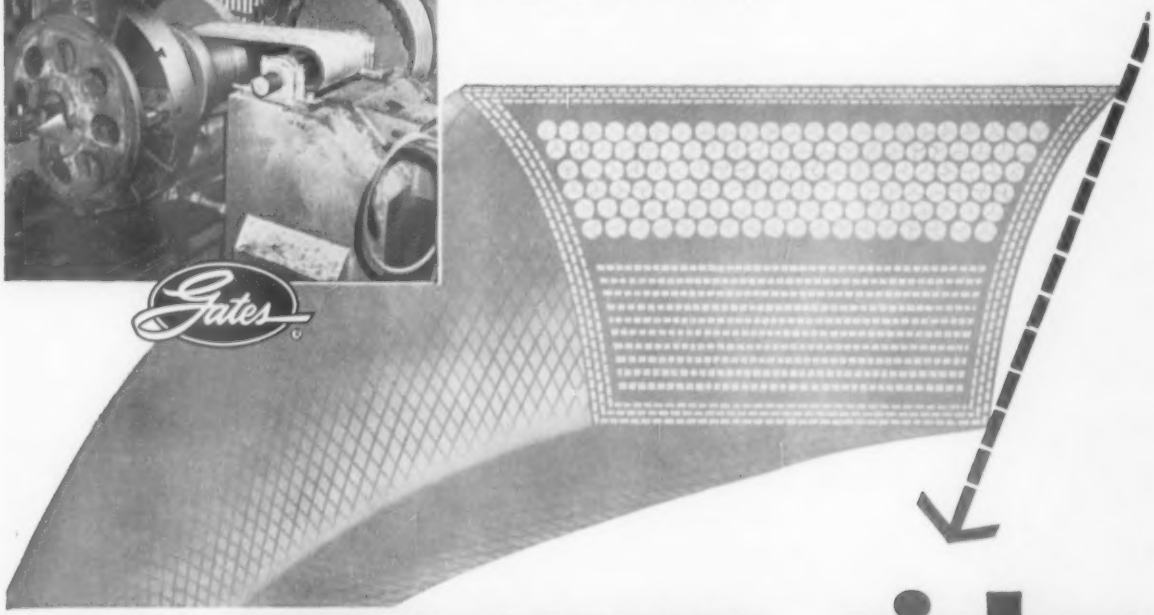


The smooth, positive flow of power transmitted through Gates Vulco Ropes enables this large engine lathe to handle quickly and efficiently many tough oil field repair jobs.



How concave sides cut V-belt costs!

Plants all over the world have made this discovery: Gates Vulco Ropes—the V-belts with *concave sides*—wear longer; cost less per year of service.

Here is the interesting reason why:

When the Gates Vulco Rope is bent around the sheave, the *precisely engineered* concave sides (Fig. 1) fill out and become straight (Fig. 1-A). Thus the belt makes full, uniform contact with the sides of the pulley. You get sure pulling power and *even distribution of wear.*

Longer wear saves not only on replacement costs; it also saves the cost of down-time... keeps equipment producing.

It's easy to prove to yourself the value of concave sides

Simply bend a straight-sided belt (Fig. 2) and *feel* the bulge at the sides around the bend. You will quickly see why the bulging sides prevent an even fit in the pulley groove (Fig. 2-A). Uneven contact shortens belt life...increases belt costs.

Cut belt replacement time and costs...specify Gates Vulco Ropes—the V-Belt with *concave sides* (U.S. Pat. 1813698). The Gates Rubber Co., Denver, Colorado—*World's Largest Maker of V-Belts.*

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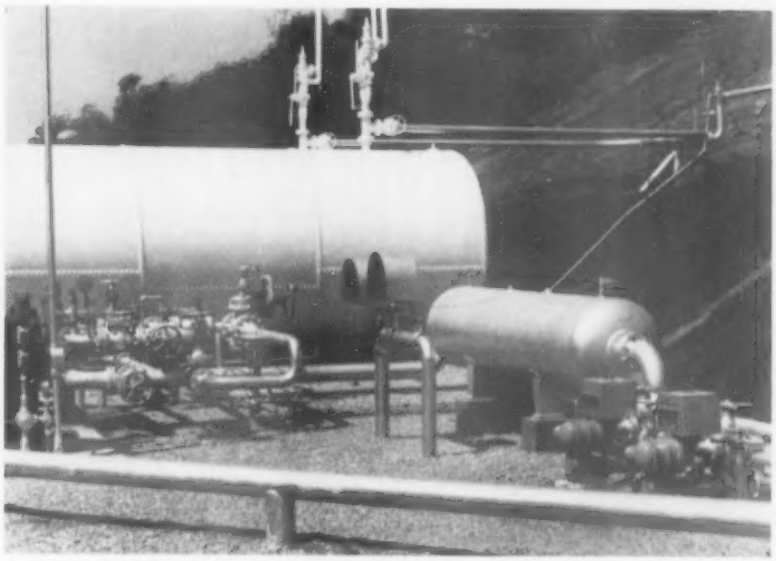


PULSATION TRAP to protect positive displacement meters from pump-caused surges is shown at right above; dampener works on acoustical trap principal. Fig. 1.

This new device traps surges in products pipeline

by W. S. Everett

A RECENTLY completed installation at Shell Oil Co.'s gasoline plant at Brea, Calif., features another step in the ever increasing use of automation.

Gasoline of 70 lb. R.v.p. is automatically shipped and metered with positive-displacement meters and float-controlled triplex plunger pump. The process is made practical by the use of a surge dampener, which protects the meter from pulsations caused by the triplex pump.

Author is with Everett & Everett, engineers, Santa Paula, Calif.

Meters vs. tank gaging . . . The conventional practice prior to shipping has always been to gage the tank, measure the temperature, and take the sample. The process as used by the Shell Oil Co., eliminates the tank gaging by using positive-displacement meters, recording thermometers, and continuous samplers.

Now the gager merely has to insert a card in the printout register of the meter to determine how many barrels have been shipped for the 24-hour period. The sample and temperature charts from the recording thermometer are picked up at the same time.

Accuracy . . . The accuracy of the system is assured by removing surges from the pipeline. Repetitive calibrations of the meter against both proving and shipping tanks show that accuracy of the positive-displacement meters is comparable to that obtainable by gaging of the shipping tank.

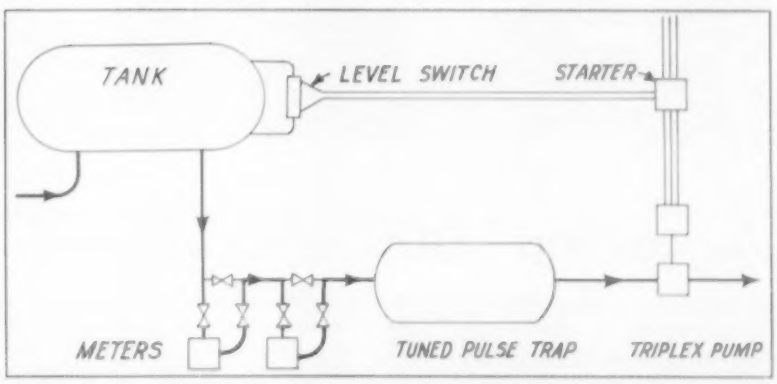
Reliability . . . The system was designed for maximum reliability. For this reason, it included the pulsation dampener. This dampener uses the elastic properties of the gasoline itself, and thereby eliminates gas chambers, Neoprene bladders, and other commonly accepted devices which must either be recharged with nitrogen or replaced when the Neoprene bladders fail or puncture.

The two meters are arranged in series with double block and bleeder valves so that each unit can be operated independently (see Figs. 1 and 2). With the two units in series, a preventive-maintenance schedule can be developed with one meter recording while the other is being serviced.

Meter wear, due to pressure pulsations, has definitely been eliminated. In this application, only a 1-psi. pulse occurred at irregular intervals (See Fig. 3).

Pressure drop . . . Meters are placed on the suction of the pump to eliminate the high-pressure meter cases and fittings. It was important that the pressure drop on the pump suction be kept to a minimum since the volatile gasoline required some 8 ft. of positive suction head. Tests indicated that the pulsation dampener imposed only 2 ft., or ½ psi., of pressure drop. This was well within the requirements.

Construction of dampener . . . The dampener uses a choke tube to bypass a conventional low-pass filter. Pressure pulsations in the pipeline are then split into two streams. The one stream passes through the low-pass filter (multiple expansion chambers) which smoothes out the pulsations. The other stream passes through a venturi-type



SCHEMATIC of Shell's Brea installation showing meters and surge dampener on suction side of positive displacement pump. Fig. 2.

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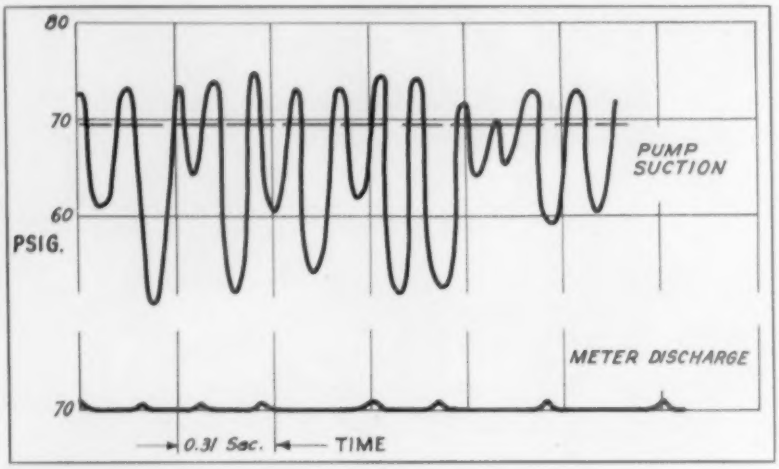


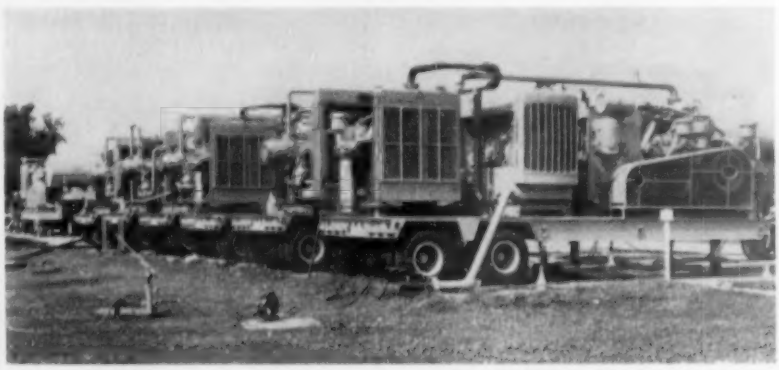
PRESSURE-TIME plot taken at pump suction and at meter discharge. Pressure humps in lower curve amount to about 1 psi. Fig. 3.

tube which chokes out the pulsations.

Both streams are united with pulsations out of phase, thereby cancelling the residual. Pulsations are eliminated over a broad frequency range from the low-frequency cutoff of the low-pass filter to a point where the phase changes at about 10 times the low-frequency cutoff.

Dimensions . . . The size of the dampener is determined not only by the pipeline size, but also by the lowest frequency of pulsations that may be encountered. For low frequencies, a long unit is dictated; for large pipelines, a large-diameter installation is required.

The "dampener" for the application at Shell's Brea gasoline plant removed pulsations produced by a triplex pump, 4-in. bore by 5-in. stroke, 91 r.p.m when pumping 70 g.p.m. of 70-lb. R.v.p. gasoline. The vessel is equipped with 6-in., 150-lb. A.S.A. flanges. It measures 30 in. in diameter by 120 in. shell length, and is designed for 150-psi. working pressure.



PORTABLE engine-compressor units will furnish air for line test.

Air-testing 1,000 miles of line!

AMERICAN LOUISIANA PIPE LINE CO. is air testing about 1,000 miles of a 30-in. gas pipe line now being constructed from Detroit to North Tepetate, La. Testing of this pipeline project began at Willow Run, Mich., during the latter part of September and will extend on into Louisiana as the line progresses.

The equipment used for this testing consists of 10 Caterpillar D337 diesel engines which furnish power for Gard-

PIPELINE PATROL

ner-Denver compressors to produce the necessary test air pressure.

Each individual test unit is composed of three engines: two low-stage compressors and one high-stage compressor. The two low-stage compressors feed directly into the suction of the high-stage compressor. The low-stage compressors develop 150 psi. and the high-stage compressor develops up to 1,000 psi.

Six men will make up the operating crew for each unit. They will operate in 8-hour shifts of two men to each shift.

When a section of line is tested, it will be brought up to 944 psi. pressure. This is a minimum of 10 per cent above the maximum operating pressure. This pressure will be checked by a dead-weight tester, and a recording chart will be made for a 24-hour test period.

After a completed section of line has been tested and the pressure check completed, the pressure will then be bled into the next section ready for test. These test sections will vary from 5 to 15 miles in length.

Trailer-mounted radio mast telescopes for faster setup

TO speed the setting up of a radio-communications system for pipeline construction, this trailer-mounted telescoping antenna mast comes in handy. It's in use by Vaughn & Taylor Construction Co., Inc. Made of aluminum, the mast is mainly supported by outriggers visible in the photo. For safety, however, it is also guyed.

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For effective coverage by the usual double-wrap method, it is necessary to overlap the tape slightly more than half its width.

See how the Xtra thickness of coal tar built into TAPECOAT-X provides extra protection per foot of tape. This extra thickness of coal tar, made possible by a new exclusive process, permits a single-wrap application that can be applied faster and over a greater area for savings in labor, material, time and money.

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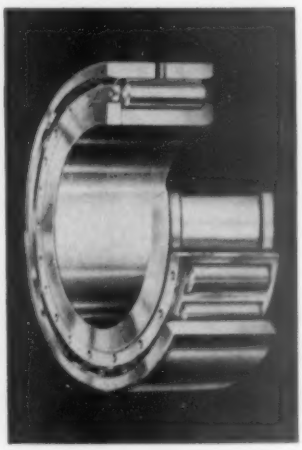

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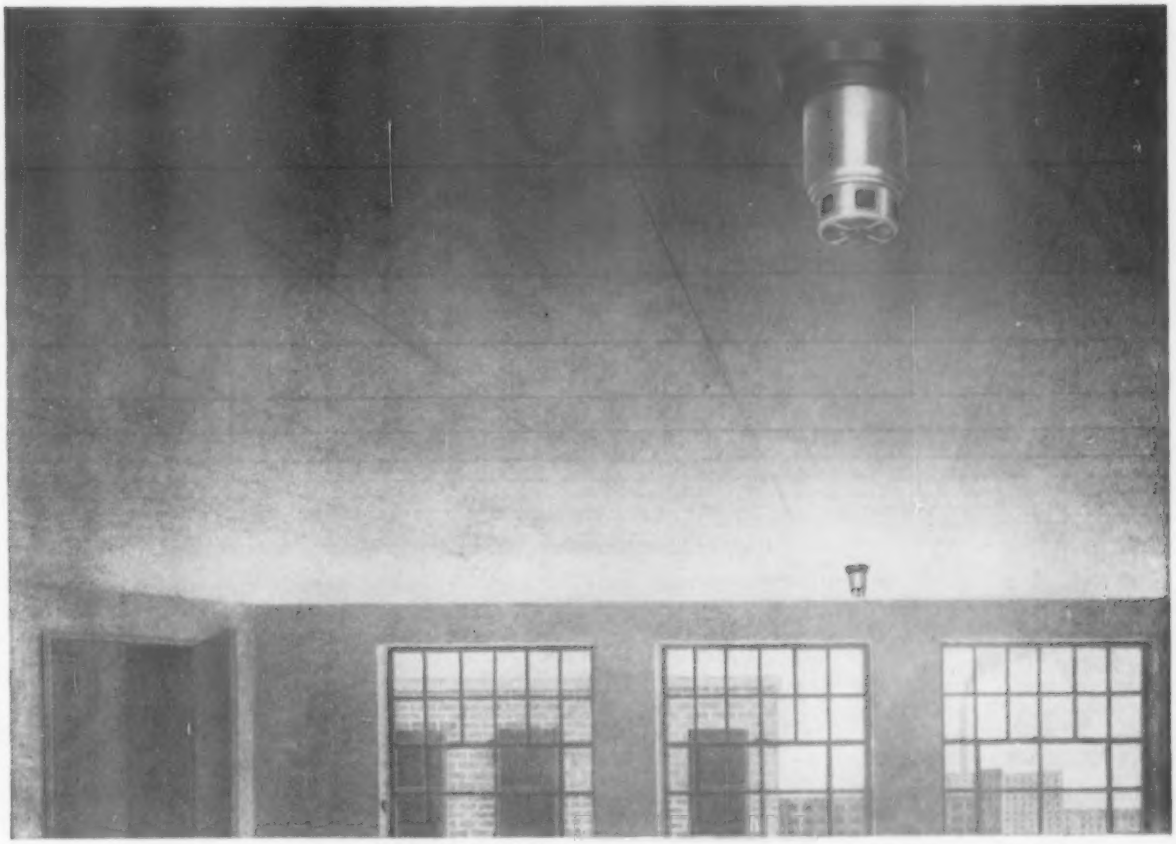

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As many pre-detector heads as necessary can be connected together in a single circuit and up to 16 separate circuits or spaces handled by one system. With a single circuit the pre-detector heads are connected directly to the fire indicating cabinet, while with multiple circuits the pre-detector heads are first connected to one or more space indicating cabinets capable of visually showing by number the exact location of the fire. Relays perform such functions as sounding alarms, closing fire doors, shutting down ventilation and releasing fire extinguishing systems.

The C-O-TWO Pre-Detector System has been subjected to extensive testing and carries Underwriters' Laboratories, Inc. listing, as well as Factory Mutual Laboratories approval. Proven pilot installations have been made in such diversified properties as a television station, an electric power company network analyzer room, a railroad signal tower, an airline flight training equipment room and the offices of an insurance company.

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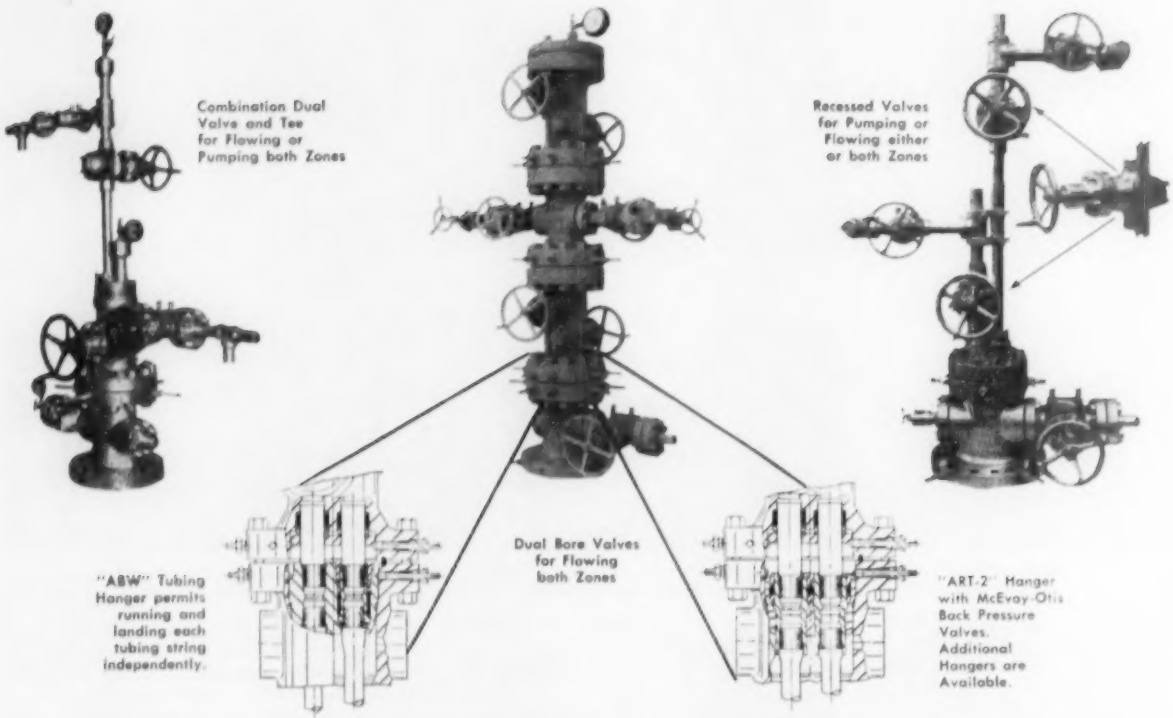
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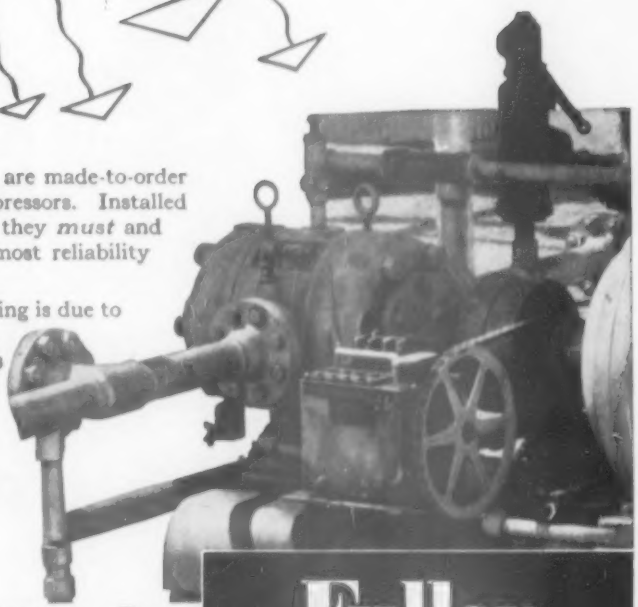

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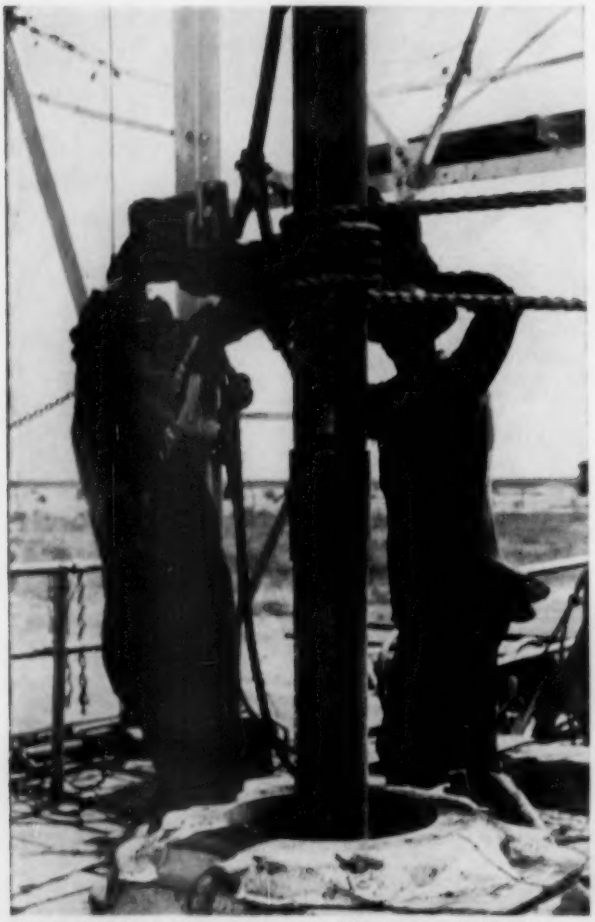

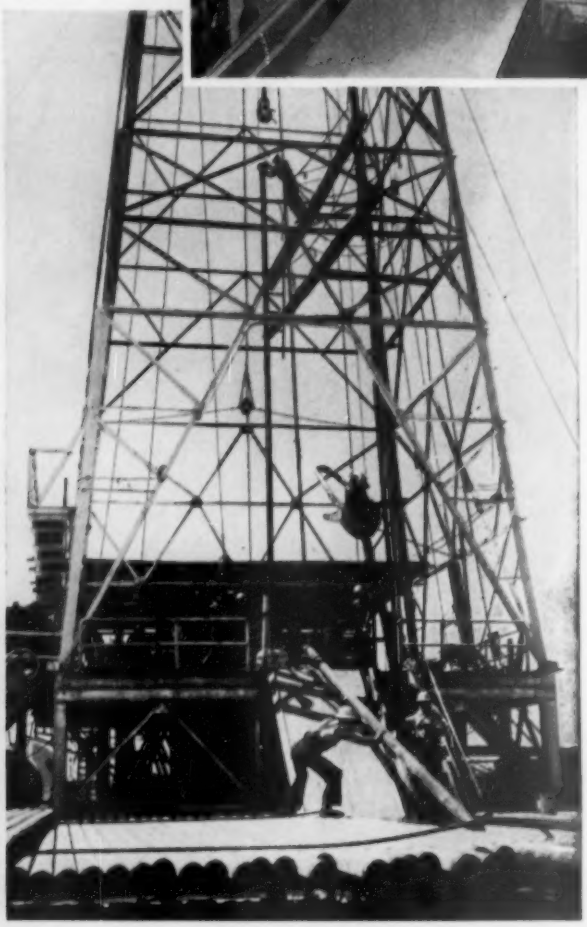

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And as an added safeguard, sections of the weld area are microscopically tested—crush resistance is measured—and each length subjected to hydrostatic pressure. Furthermore, the uniform thickness of steel under thread roots insures strong joints—with no weak spots to invite costly pullouts.

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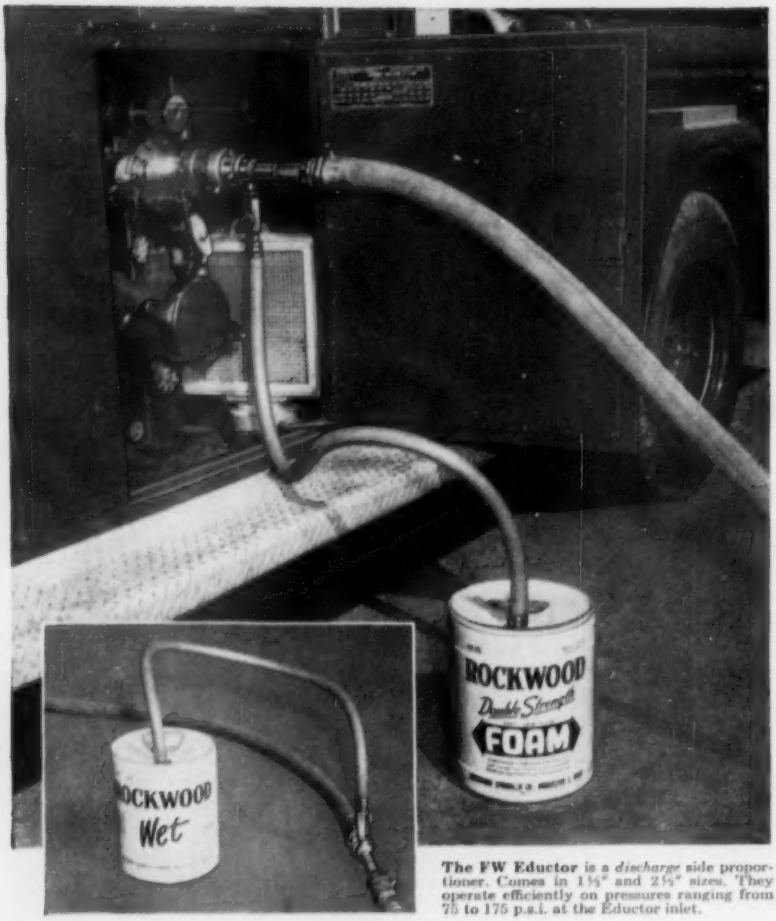
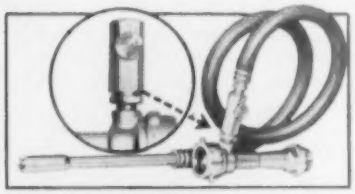


The FW Eductor is a *discharge* side proportioner. Comes in 1½" and 2½" sizes. They operate efficiently on pressures ranging from 75 to 175 p.s.i. at the Eductor inlet.

FFF Nozzle comes with Foam screen and solid Foam stream shaper.

Rockwood Eductors are designed for use with both the Rockwood FFF nozzle and the SG-60 nozzle with FF extension unit. SG-60 is an all-purpose nozzle that fights fires 5 ways — high velocity WaterFOG, low velocity WaterFOG (with applicator), FogFOAM, solid stream of water or of FOAM. FF extension unit discharges Rockwood FOAM in a solid stream or as FogFOAM, and covers large areas at one time.



The Variable FW Metering-Check Valve on the Rockwood Eductor is highly versatile, and is furnished with each FW Eductor. It incorporates both the Metering Valve and Ball Check Valve in one unit, and meters material into the hose line in any proportion from 1% through 6%.

One for the road!

Protect against flammable liquid fire due to tank truck accidents

With more traffic on congested highways, more filling stations, more and more gasoline tank trucks in daily service, *your* city is in greater danger of a flammable fuel fire than it has ever been before. A sudden crash of a tank truck passing through your city streets tomorrow could confront you with a difficult-to-control flammable liquid fire.

The use of Rockwood FW Eductor reduces the danger of disastrous losses due to such a fast-spreading fire. Developed for operation with Rockwood's FFF nozzle and SG-60 nozzle with FF extension unit, the FW Eductor introduces Rockwood regular FOAM, Double-Strength FOAM or WET (1% or 2%) into the hose line, quickly controlling and extinguishing flammable liquid and other fires.

Rockwood FW Eductor is the simplest form of proportioning you can buy. Ideal for municipal fire departments, oil refineries and industrial plants, it can be attached between discharge gate of a fire truck and hose line, or between hydrant and hose line, or between two lengths of hose.

Be prepared. Put this great fire fighter to work for you. Specify Rockwood FW Eductor when you order a fire truck.

Rockwood Double-Strength Foam Liquid, 3 parts mixed with 97 parts water, forms a solid FOAM blanket that quickly re-seals itself. Available in 5-gallon or 50-gallon drums.

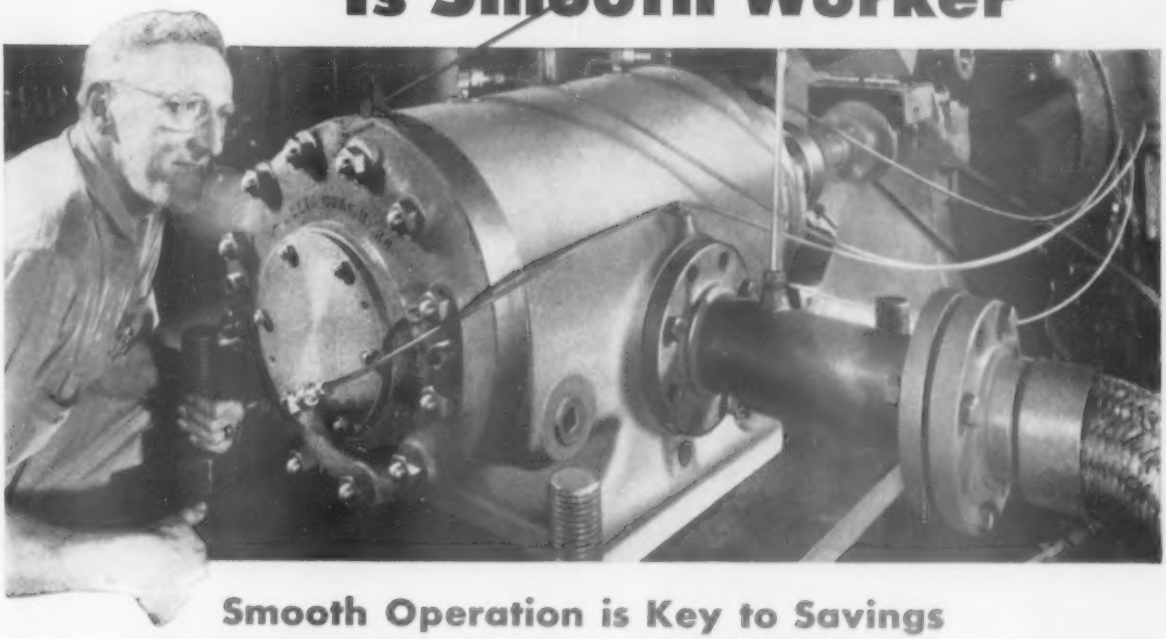
Rockwood WET, 1 part mixed with 99 parts water, increases penetration and extinguishing action of water. Excellent for deep seated fires or where water is scarce. Can be used in proportions of 1% or 2% by volume for Class A and B fires. Available in 5-gallon cans or 50-gallon drums.

ROCKWOOD SPRINKLER COMPANY

Engineers Water . . . to Cut Fire Losses

PORTABLE FIRE PROTECTION DIVISION • 1066 Harlow Street, Worcester 5, Mass.

Coin Trick Proves
RO-FLO COMPRESSOR
Is Smooth Worker



Smooth Operation is Key to Savings

Everybody around the place knew the *Ro-Flo* compressor was a smooth operator. But just how smooth?

Someone suggested the old coin trick . . . balance a coin on it while it's running.

The next we knew the foreman was calling, "Come down and see for yourself." We went to the shop. And sure enough, there the penny was standing as still as you please.

What does that mean to you?

It means, here's a compressor that needs practically no foundation. And it means there's no wear and tear from vibration...less maintenance.

You get constant air supply with this machine, too. For this story: Call your nearby A-C office for complete information, or write Allis-Chalmers, Industrial Equipment Division, Milwaukee 1, Wisconsin.

A-4716

Ro-Flo is an Allis-Chalmers trademark.

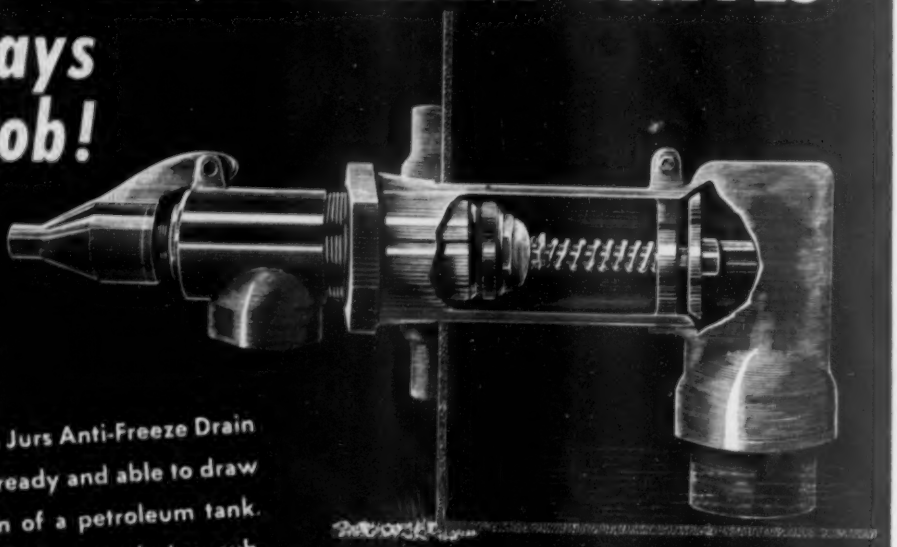
ALLIS-CHALMERS

A-C ALLIS-CHALMERS

Ro-Flo compressors provide constant efficiency and air supply for air tools

S&J ANTI-FREEZE DRAIN VALVES

Always on the Job!

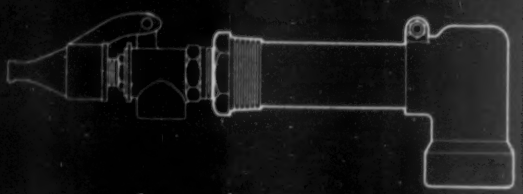


Here's the Shand & Jurs Anti-Freeze Drain Valve that is always ready and able to draw water off the bottom of a petroleum tank. It will remain operable even during sub-freezing weather conditions. It's self draining; water will not remain inside the valve body. Obviously the valve cannot freeze up and become inoperable.

The unique design of the S&J Anti-Freeze Drain Valve, designated as Fig. ST-2001, calls for mounting in strong threaded flange or coupling welded into the tank shell so that threads do not warp. This prevents loss of product and incidental hazards, and facilitates removal of the drain valve for cleaning or maintenance.

Above. Fig. ST-2001 AV Anti-Freeze Drain Valve with auxiliary valve which permits removal of the Drain Valve from a tank without draining tank contents.

Fig. ST-2001 Anti-Freeze Drain Valve with adapter for Cone roof tanks.



The S&J Anti-Freeze Drain Valve, Fig. ST-2001 is available in 2", 3" and 4" sizes.

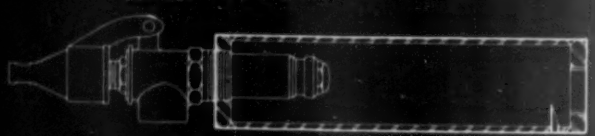


Fig. ST-2001 S Anti-Freeze Drain Valve with eccentric sleeve is designed for use in Spheroids and other tanks with curved bottoms.

Shand and Jurs Co.
BERKELEY 10, CALIFORNIA

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342 Madison Ave.

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M & M Bldg.

TULSA
Thompson Bldg.

CHICAGO
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REPRESENTATIVES

SEATTLE: Nebar Supply Company, 3000 Western Avenue
MONTREAL: Lytle Engineering Specialties, Ltd., 360 Notre Dame St. W
TORONTO: Lytle Engineering Specialties, Ltd., 69 Eglington East
VANCOUVER: P. D. McLaren & Son, Ltd., 3277 Main Street
CARACAS: Sinclair Spence, C.A., Edificio Galipan
ENGLAND: Whessoe, Ltd., Sales: 25 Victoria St., London S. W. 1
Whessoe, Ltd., Works: Darlington County Durham

Pictured left to right, Mr. Porter Bilbo and Mr. Joe Redding standing before their Wheland HP-18000 Duplex Power Slush Pump on location in the Houston area.

"Achieved the *utmost* . . . in *rugged service* . . . *day in and day out*"

—J. E. Redding, President
Bilbo-Redding Drilling Co., Inc.

DEPENDABLE!
LOWER MAINTENANCE!
INCREASED PROFITS!

WHELAND HP-18000

7¾" x 18"

DUPLEX POWER SLUSH PUMP

750 Horsepower—Nominal Input at 60 RPM

1322 lbs. mud pressure with 7¾" liner
2700 lbs. mud pressure with 5½" liner

BILBO-REDDING DRILLING CO., INC.
POST OFFICE BOX 302
HOUSTON 1, TEXAS

August 11, 1955

Mr. Gordon P. Street, President
The Wheland Company
Chattanooga, Tennessee

Dear Sir:

We thought it only fitting and proper that we should advise you concerning the operations of our Wheland HP-18000 Heavy Duty Power Slush Pump purchased several months ago.

This pump has achieved the utmost in our expectations and requirements for the rugged service which it is called upon to perform each hour of each day, day in and day out.

Our footage costs are down and our drilling profits up. To our firm this can mean but one thing, the survival of the Contractor which is so essential to the great Oil Industry. The only answer to the newly increased cost of equipment and labor to the Contractor is for mechanical research to continue in the development of equipment that will perform a more efficient job such as The Wheland Company has done in the presentation of your HP-18000 Pump.

Sincerely Yours,

Bilbo-Redding Drilling Co., Inc.

J. E. Redding

J. E. Redding, President

Weight 36,377 lbs. Compact—Easily Moved *In One Piece*! Write For Detailed Bulletin

WHELAND

ROTARY DRILLING MACHINERY

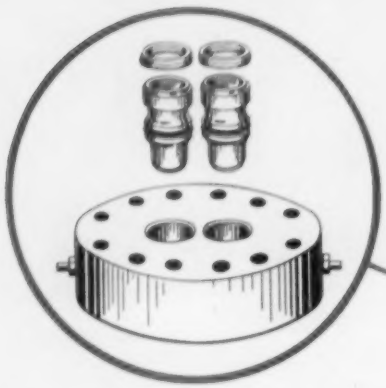
THE WHELAND COMPANY, CHATTANOOGA, TENNESSEE, U. S. A.
DRAW WORKS • SLUSH PUMPS • ROTARIES
CROWN BLOCKS • TRAVELING BLOCKS • SWIVELS

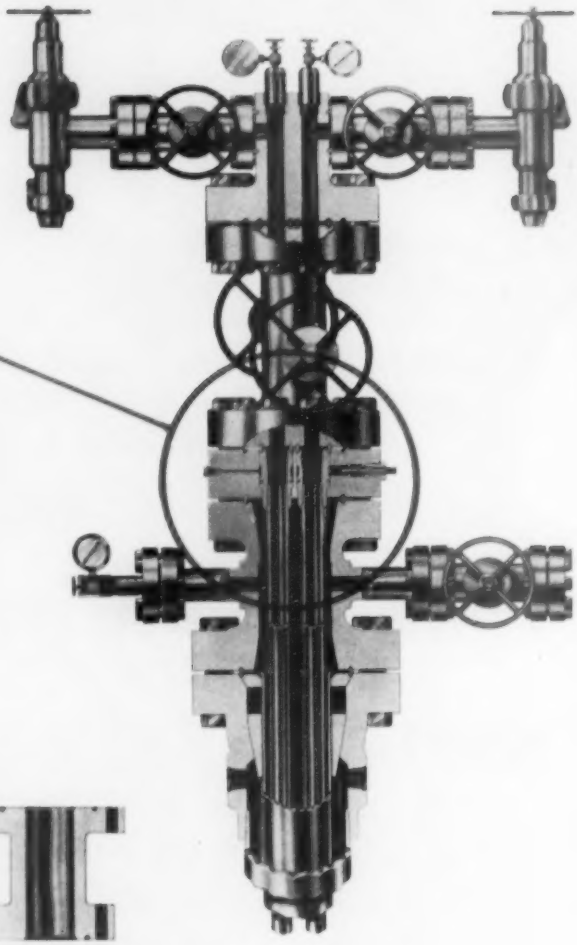
DOMESTIC DISTRIBUTORS: INDUSTRIAL SUPPLY COMPANY, INC.—Main Office: Wichita Falls, Texas • HOUSTON OIL FIELD MATERIAL COMPANY, INC.—Main Office: Houston, Texas • JONES AND LAUGHLIN STEEL CORPORATION, SUPPLY DIVISION—Main Office: Drawer 2481, Tulsa 2, Oklahoma.

EXPORT DISTRIBUTORS: LUCEY EXPORT CORPORATION—233 BROADWAY, NEW YORK 7, N. Y.—Broad Street House, London, E. C. 2, England.

RECTOR Dual-String Hanger Flange

Outstanding Simplicity and Flexibility, plus the FAMOUS Rector Metal-to-Metal Seal





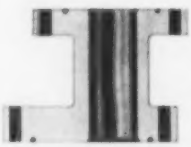
SIMPLICITY: The flange has two full opening tapered bores in which the strings are suspended by threaded mandrels. This eliminates mating and sealing two tubing hangers in a single, large bore. Each string can be suspended, temporarily sealed, and held down independently of the other assuring maximum ease of installation with complete control of well.

FLEXIBILITY: Regular 2" API upset tubing can be run or pulled through the bores in the flange.

METAL-to-METAL SEALS: Each mandrel is independently sealed by a metal seal ring in the groove at the junction of mandrel and flange. This metal-to-metal sealing arrangement also acts as a hold-down. "O" Rings on the mandrel provide a temporary seal during completion and permit testing the seal after Christmas Tree is installed. Mandrels are grooved for hold-down locking screws, which are optional in the flange.

• **Rector Dual-String Hanger Flanges are available in Nom 6 and Nom 8 sizes in any series. Mandrels are interchangeable.**

For maximum simplicity and flexibility of dual-string suspension, plus the metal-to-metal seal that never requires maintenance or replacement, specify a Rector Dual-String Hanger Flange in your dual completion Christmas Tree.



Off-Set Adapter Spool permits use of regular preventer equipment with alignment directly over each individual bore while running and pulling tubing. After first string is run, Adapter Spool can be rotated to center directly over the other bore.

25 YEARS

RECTOR WELL EQUIPMENT COMPANY INC

• MAKING THE OIL INDUSTRY SAFER •

1100 NORTH COMMERCE ST., FORT WORTH, TEXAS

Houston Plant: 9215 Commerce St.

REPRESENTATIVES IN ALL ACTIVE FIELDS

The first modern petroleum refinery in the Republic of Turkey is now on stream. Crude is supplied by a field gathering system and pipe line that began operation in December, 1953. Complete design, procurement of materials, construction, personnel training, and initial operation were performed by PARSONS for Türkiye Petrolleri Anonim Ortaklığı.

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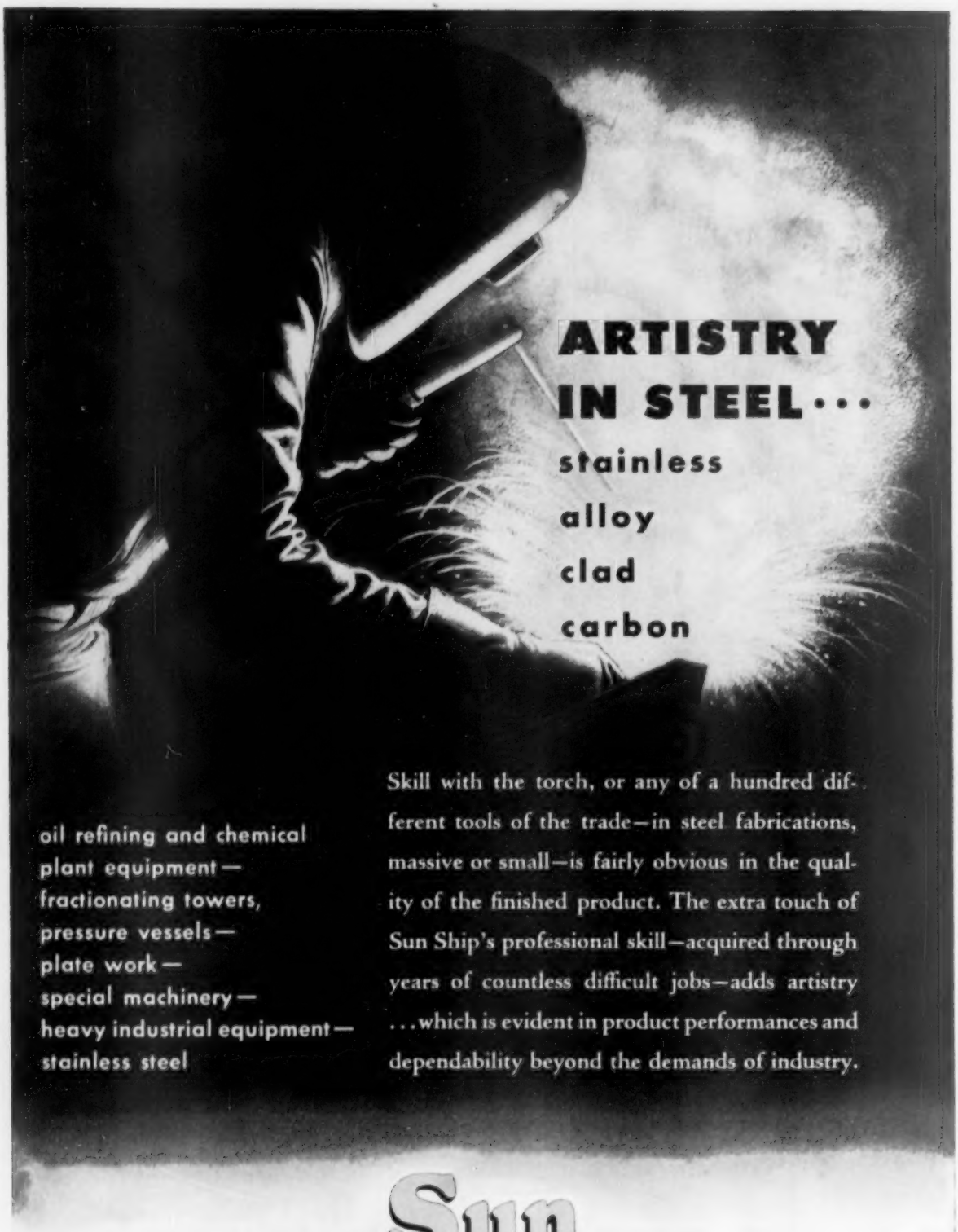
ARTISTRY
IN STEEL···
stainless
alloy
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oil refining and chemical
plant equipment—
fractionating towers,
pressure vessels—
plate work—
special machinery—
heavy industrial equipment—
stainless steel
Skill with the torch, or any of a hundred different tools of the trade—in steel fabrications, massive or small—is fairly obvious in the quality of the finished product. The extra touch of Sun Ship's professional skill—acquired through years of countless difficult jobs—adds artistry ...which is evident in product performances and dependability beyond the demands of industry.

Sun

SHIPBUILDING & DRY DOCK COMPANY

SINCE 1916

ON THE DELAWARE • CHESTER, PA.

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R. T. "Bob" Penny, Supervisor in the Mid-Continent and the Rocky Mountain Areas, is typical of IX executives. Having been with the company since 1939, Bob at one time or another has held practically every field job on an IX seismograph crew.

DERRICKS TODAY
Where I.X. Parties Were Yesterday

All Independent Exploration personnel—from the administrative level to working parties—are intimate with the requirements of a successful geophysical survey. This knowledge of field operations was gained in more than 22 years of intensive field work by men who, though now in executive positions, know the importance of a detailed, accurate survey. These men realize the value of prior planning for a survey and when to use time and cost saving "short cuts." This wealth of IX experience will guarantee you a better return from your survey investment.

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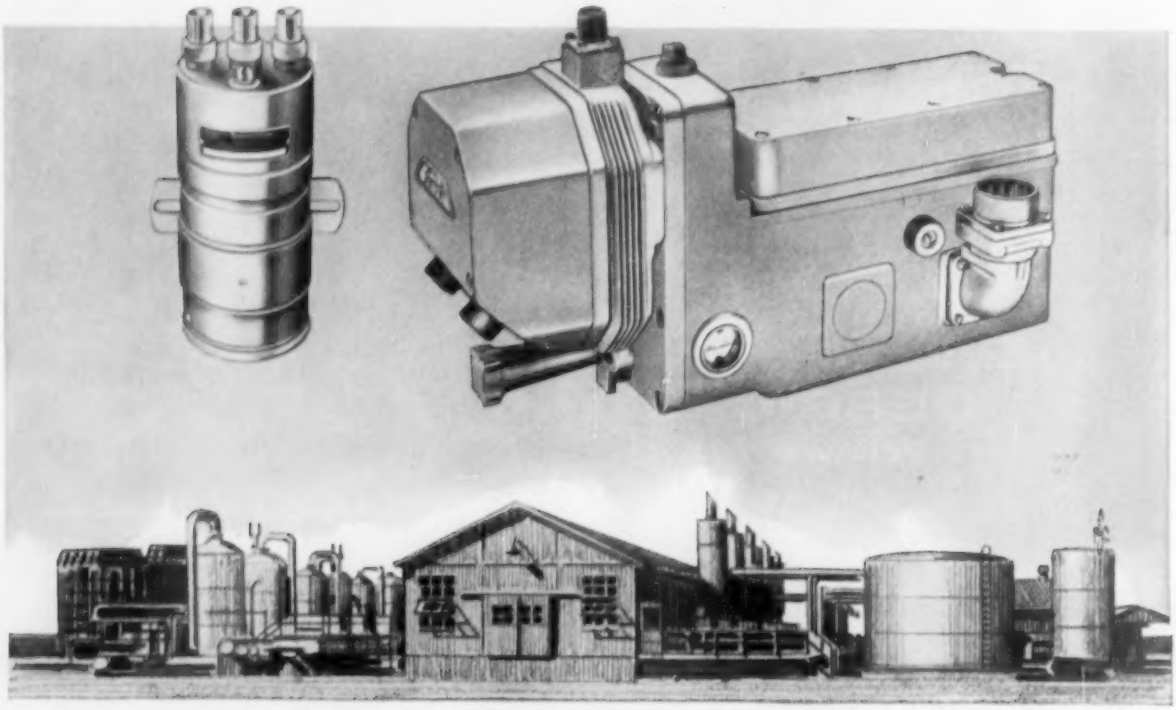
Bendix —*the most trusted name in ignition*—

Presents a New Matched Ignition System



Designed Specifically for the Petroleum Industry

OUTSTANDING FEATURES

Long service life

No unscheduled ignition shutdowns

High voltage output

Matched ignition components

Flame proof

The Bendix* LC Magneto has been engineered to meet the exacting requirements of the modern high-compression gas engines so widely used throughout the petroleum industry.

Because the Bendix LC is a completely new type of magneto, it incorporates the latest developments in materials, engineering, design and production techniques. The result is a matched ignition system—LC Magneto plus Bendix Hi-V Transformer Coils—that delivers ample voltage with greatly reduced maintenance costs.

For engines of 6 to 16 cylinders where top performance is a must, the new Bendix LC Magneto is the logical choice.

Complete descriptive folder is available on request.

*TRADE MARK

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Export Sales and Service: Bendix International Div., 205 East 42nd St., New York 17, N.Y.

FACTORY BRANCH OFFICES

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Now... You can have 4500 Gallons of Foam per minute!

with a range of 180 FT.

Nozzle tip with foam deflectors open permits powerful straight stream.

Nozzle tip with foam deflectors closed forms a wide fan-shaped pattern.

with the *NEW*

AMERICAN LAFRANCE

"Blabbermouth" AIRFOAM TURRET NOZZLE

Here's tremendous fire-extinguishing power and capacity . . . 4500 g.p.m. of fully formed foam at 150 p.s.i. . . . especially designed for unenclosed areas which contain risks that cannot be protected with other types of fire extinguishing devices.

Fast and easy to operate, the "Blabbermouth" can be mounted on a fixed base or mobile equipment. An instant-acting lever control can change its 180 ft. straight stream to a fan spray 30 ft. wide with an 80 ft. range. It can be directed 360° around the vertical axis and about 90° from horizontal axis. Write today for detailed information.

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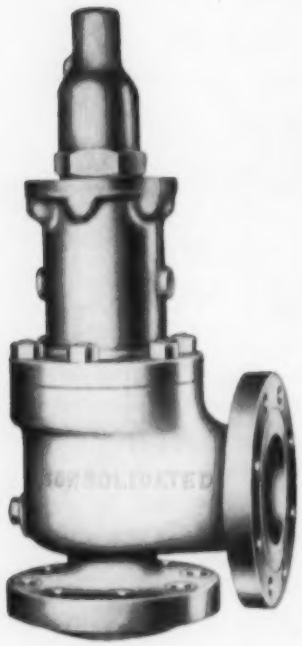
ELMIRA, NEW YORK, U. S. A.

LAFRANCE FIRE ENGINE—FOAMITE LIMITED
TORONTO, 9, ONTARIO, CANADA

NOW...CONSOLIDATED SAFETY RELIEF VALVES

in economical "2 in 1" design

Peak performance . . . positive valve action assured . . . even where discharge lines are long, or low "superimposed" back pressure exists in the relieving system.



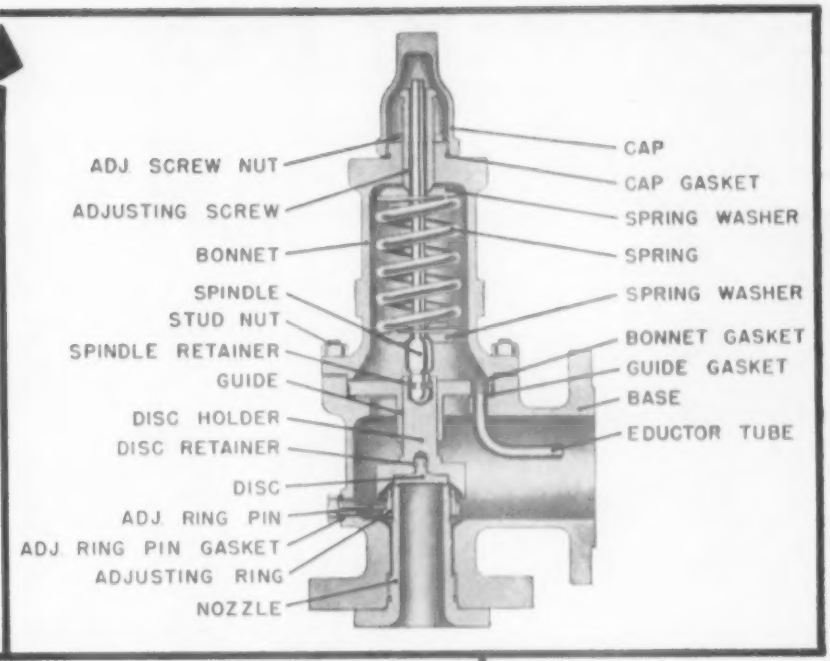
"Two-In-One" design, improved performance . . . the new Consolidated Safety Relief Valve is the result of over 4,000 flow tests in 5 years at West Edmond, Oklahoma. At the A.S.M.E.-approved testing station there, natural gas is available in flow capacities up to 35,000 cfm and pressures up to 500 psig. The A.S.M.E.-approved conditions, apparatus, and procedures permitted Consolidated engineers to test-develop and prove the full range of valve sizes and pressures in both Standard and Bellows designs.

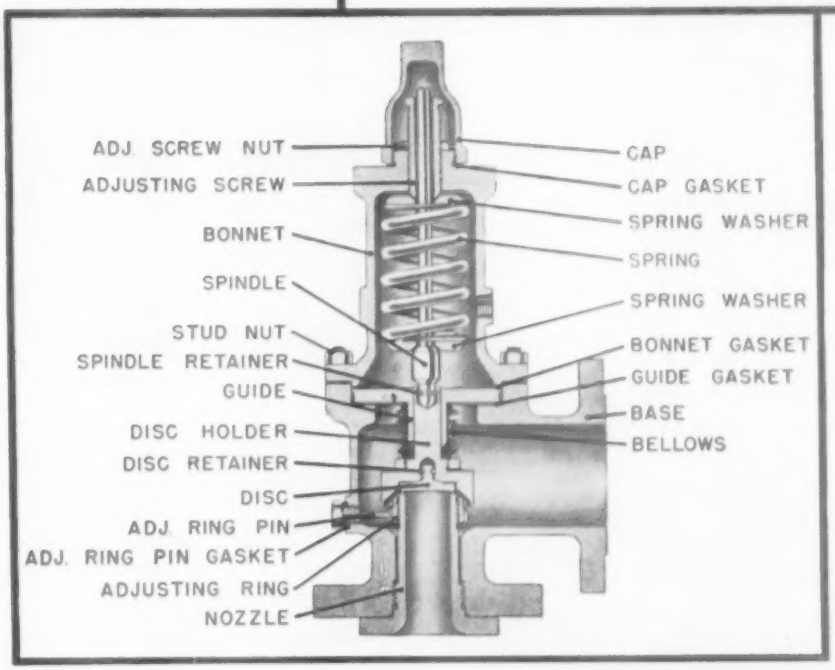
Interchangeability is so highly developed that the majority of Consolidated Standard Valves can be converted to the Bellows design, in the field, simply by installing the bellows. Each type has fewer functional parts than other comparable safety relief valves. Standardization of inlet and outlet center-to-face dimensions permits interchangeability with a large proportion of the valves of other manufacturers. Incorporated is an optically-ground flat seating surface that contributes to easier, more economical maintenance.

You can have the absolute protection and real economy of the thoroughly tried and proved Consolidated Safety Relief Valves for your plant today. Both Standard and Bellows types are available in sizes and pressures to meet requirements of the most advanced processing facilities. Write for full details. Ask for Catalog 1900.

CONSOLIDATED SAFETY RELIEF VALVES

STANDARD VALVE has an eductor tube that holds the pressure in the valve bonnet to approximately atmospheric pressure; thus only the force of the spring controls the valve. Valve action is improved and stabilized . . . repetitive flow capacity is provided . . . a new high in operational dependability is assured. Even under repeated popping of the valve, set pressure and blowdown are consistent. The valve will open to full capacity at 3% overpressure regardless of the position of the adjusting ring.





BELLOWS VALVE is like the Standard but has a durable, two-ply stainless steel sealing bellows which effectively isolates from the valve's working parts any contaminants, corrosion, or viscous fluids. The bellows is balanced with the seating surface: set pressure of the valve is not affected by back pressure, whether constant or variable. Consequently, smaller discharge piping can be used, thus reducing the cost of pressure-relieving systems.

Certified and Approved

Both Standard and Bellows Valves are approved under A.P.I.-A.S.M.E. Unfired Pressure Vessel Codes, A.S.M.E. Unfired Pressure Vessel Code and are certified by the National Board of Boiler and Pressure Vessel Inspectors.

CONSOLIDATED 1879 U.S.A.

A PRODUCT OF MANNING, MAXWELL & MOORE, INC.

TULSA, OKLAHOMA

MAKERS OF 'AMERICAN' INDUSTRIAL INSTRUMENTS, 'ASHCROFT' GAUGES, CONSOLIDATED' SAFETY AND RELIEF VALVES, 'AMERICAN-MICROSEN' INDUSTRIAL ELECTRONIC INSTRUMENTS, *Stratford, Conn.* 'HANCOCK' VALVES, *Watertown, Mass.* AIRCRAFT CONTROL PRODUCTS, *Danbury & Stratford, Conn. and Inglewood, Calif.* "SHAW BOX" AND 'LOAD LIFTER' CRANES, 'BUDGIT' AND 'LOAD LIFTER' HOISTS AND OTHER LIFTING SPECIALTIES, *Muskegon, Mich.*

EQUIPMENT MEN . . . in the News

Bechtold to Head Emsco Mast, Structural Sales

Emsco Manufacturing Co. has announced the appointment of Jack R. Bechtold to head its mast and drilling - structural sales.

For the past 6½ years Bechtold has been working in design and sales with Lee C. Moore Corp. of Tulsa. Experience prior to his Navy duty included 3 years of roughnecking.

As manager of mast and drilling-structural sales, he will headquarter in Emsco's general sales offices in Dallas.

Oilwell Makes McCarthy City Representative

Appointment of David E. McCarthy as city representative at Evansville, Ind., for U. S. Steel's Oil Well Supply Division has been announced by C. H. Maynard, manager of Oilwell's eastern area.

McCarthy joined Oilwell in 1937 at its Imperial Works at Oil City, Pa., and was employed in various departments there until 1941 when he was granted leave of absence to serve with the U. S. Army. He returned to the supply firm in 1945 at its Mount Carmel, Ill., store. In 1948 he was named manager of that store, holding this position until his latest appointment.

Refinery Supply Co. Shifts I. C. Ray and R. L. Holman

The following changes in sales personnel for Refinery Supply Co. have been announced by J. B. Okeson, vice president.

Ivan C. Ray, sales engineer, has transferred to the Houston office and has been promoted to the position of branch manager.

IVAN C. RAY

R. L. HOLMAN

R. L. Holman is replacing Ray in the Tulsa area sales position.

The Houston office serves the entire Gulf Coast area with a complete line of laboratory apparatus and gas-testing specialties.

Ray has been with Refinery Supply for over 2 years and has over 10 years' experience in the laboratory-apparatus and instrument field.

Holman is a chemical engineer and has been employed with Stanolind Oil & Gas in gasoline-plant operations and with Skelly Oil Co.'s research group.

Dowell Shifts Davis, Briscoe to Tulsa Posts

Earl J. Davis and Harold R. Briscoe, formerly area managers in Dowell's Illinois and Texas Gulf Coast districts, are now located at the company's general offices in Tulsa, according to A. C. Polk, general manager. Davis will be assistant to the general manager, and Briscoe will be a member of the personnel department.

Expansion into new areas, development of new products and services has made it necessary for the Dowell management to have available dependable, up-to-date information on industrial activity to aid in making decisions on future and long-range plans, Polk said. Davis, who will handle this assignment, will also provide company management with economic and financial information.

The coordination of activities concerned with the development of people to fill positions created by company growth will be Briscoe's responsibility, reported W. N. Estel, director of personnel. In this work he will be assisted by Perry Arnot, safety engineer.

E. J. DAVIS

H. R. BRISCOE

The vacancy created by Davis' promotion is being filled by James R. Paul, who is being transferred from Wichita. Replacing Paul in the Kansas district office will be S. R. West, who has been petroleum engineer for Dowell at Great Bend.

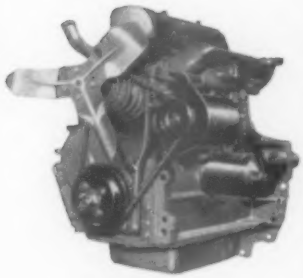
McNeely Joins Inco's Texas Technical Section

Branch M. McNeely, Jr., has joined the development and research division of International Nickel Co., Inc., as a member of the Texas technical field section with headquarters at Houston, according to an announcement by Donald J. Reese, assistant manager of the division.

McNeely joined Houston Oil Field Material Co. in 1948 and conducted

Houston Nomads Entertain International Visitors

International visitors at the October meeting of Houston chapter Nomads were: front row, George B. Saunders, Mene Grande Oil Co., San Tome, Venezuela; Henry Reed, Lehman Brothers, New York; Joao Lopes Da Silva, Socony Vacuum, Lisbon, Portugal; Clinton O. Williams, University of Houston, Houston; B. C. Corbin, Byron Jackson, Mount Carmel, Ill. In the back row are: H. J. Baker, Iraq Petroleum Co., Kirkuk, Iraq; J. C. Kiker, Texas Petroleum Co., Caracas, Venezuela; E. P. Markham, Mene Grande Oil Co., San Tome, Venezuela; E. W. Paddock, British Petroleum, Ltd., Khanek, Iraq; Charles Wickens, Shell D'Arcy, Owerri, Nigeria, West Africa; D. V. Smith, Heathman-Seelighson, Pescara, Italy; John M. Hardy, Hardy-Griffin Engineering Co., Houston.



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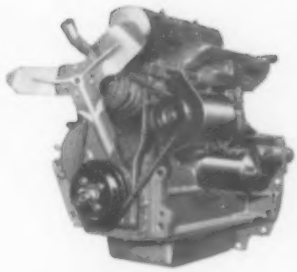

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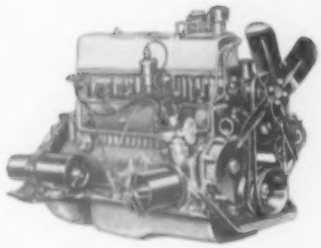
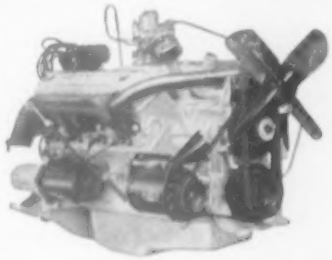


FORD "223"

NOW!

ONLY FORD OFFERS 4-6- and V-8 Overhead Valve Short Stroke Industrial Engines



FORD "272"

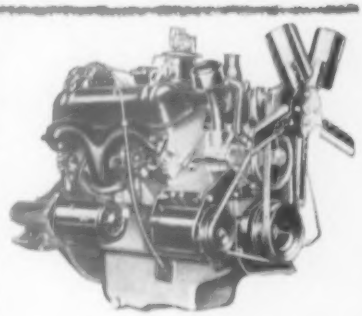
FOR '56—A FORD EXCLUSIVE!

Every Industrial Engine is of Short Stroke Design! New Ultra-modern Overhead-Valve Construction! Years Ahead in Engineering! Engines That Give Power-Packed Performance . . . Economical to Operate . . . Last Longer

Ford
INDUSTRIAL ENGINES AND POWER UNITS

• For '56—*every* Ford Industrial Engine and Power Unit is Short Stroke! These vastly superior engines are available to you in 4- 6- or V-8 cylinders and in displacements from 134 to 332 cubic inches. *Only* Ford offers *all* engines with Short Stroke design—engines that have *large* cylinder bores and short strokes for *low* piston speeds. And, because of such short piston travel, friction is cut, wear is reduced so that *engines last longer!*

Tests prove that, in their respective displacements, Ford engines deliver *more* power on *less* fuel. If you plan to *modernize* your equipment be sure to get the most modern power available—Ford *Short Stroke* Industrial Engines.



FORD "332"

SPECIFICATIONS OF FORD INDUSTRIAL ENGINES AND POWER UNITS

SERIES	CYLINDERS	BORE & STROKE	DISPL. CU. IN.	COMP. RATIO	DYN. B.H.P.	DYN. MAX. TORQUE
134	4	3.44 x 3.60	134	6.6 to 1	48 @ 2800	110 lbs.-ft. @ 1400 rpm
172	4	3.90 x 3.60	172	6.75 to 1	61 @ 2800	148 lbs.-ft. @ 1400 rpm
223	6	3.62 x 3.60	223	7.8 to 1	107 @ 2800	202 lbs.-ft. @ 2000 rpm
272	8	3.62 x 3.30	272	7.6 to 1	131 @ 2800	249 lbs.-ft. @ 2400 rpm
332	8	3.80 x 3.66	332	7.5 to 1	160 @ 2800	308 lbs.-ft. @ 2300 rpm

FORD Foot Mounted Power Unit

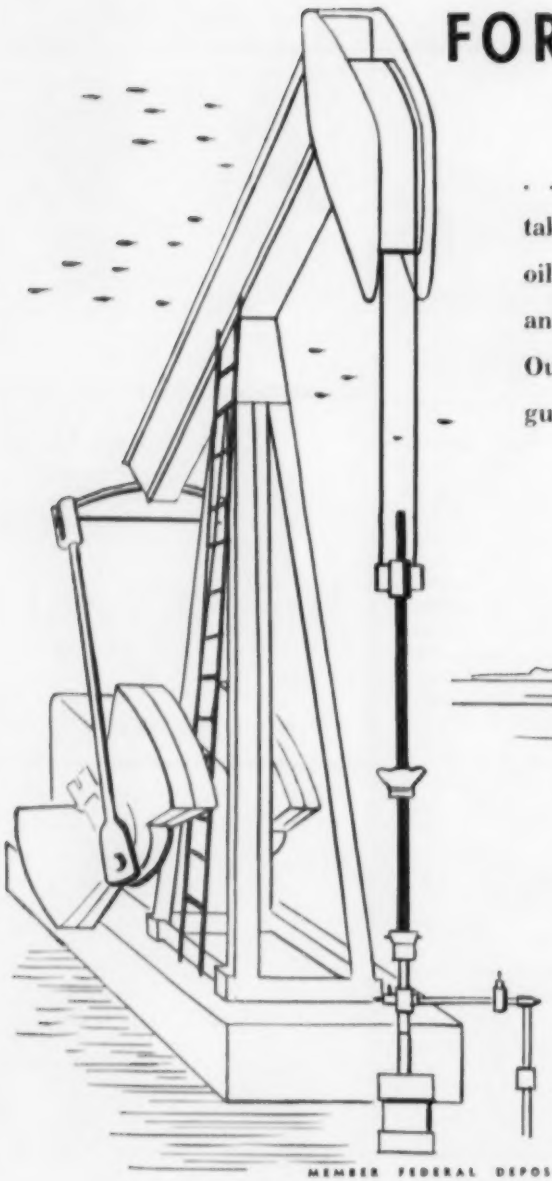
FORD Skid Mounted Power Unit

INDUSTRIAL ENGINE DEPARTMENT

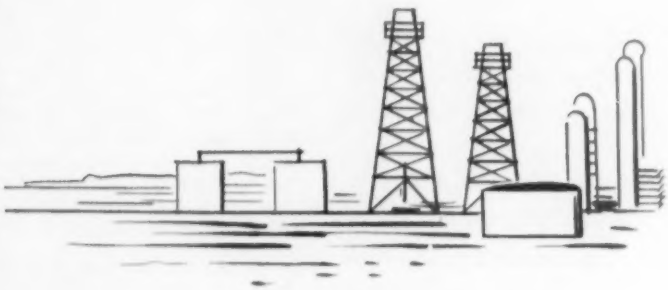
FORD Division of Ford Motor Company

P. O. Box 598, Dearborn, Michigan

IT TAKES *Money* FOR OIL PRODUCTION



. . . Yes, conducting any oil production program takes money—plenty of it! National Bank of Tulsa's oil department is familiar with oil finance needs and is always ready to discuss them with oil men. Our resources, facilities, and "know-how" are your guarantee of prompt, efficient, adequate service.



NOW IS THE TIME
TO DISCUSS YOUR
OIL FINANCE NEEDS

MEMBER FEDERAL DEPOSIT INSURANCE CORPORATION

NATIONAL BANK OF TULSA

The Oil Bank of America

OFFERING COMPLETE BANKING AND TRUST SERVICES

magnetic surveys of directionally drilled well bores both on and offshore. In 1953 he was appointed assistant chief engineer and served in that capacity until joining International Nickel.

Fisher Made Wheatley Pump V. P. and General Manager

Robert W. Fisher, sales manager for Frank Wheatley Pump & Valve Manufacturing Co. since 1952, was recent-

R. W. FISHER

O. L. SUMNER

ly appointed vice president and general manager. The announcement was made by Frank Wheatley, Sr., company founder and chairman of the board of directors.

Other changes in management personnel, coincident with Wheatley's $300,000 expansion program, include the appointment of Orbie L. Sumner as assistant general manager and Jack E. Metzger as secretary-treasurer. Sumner was formerly pilot and service manager. Gus Baker will continue to serve as vice president and sales manager for the affiliated companies.

Frank Wheatley, Jr., president of the company, will become more active in the operation of the two associated companies, Frank Wheatley Supply Co. with headquarters in Tulsa, and a Canadian subsidiary, Wheatley Equipment & Supply Co. with headquarters in Edmonton.

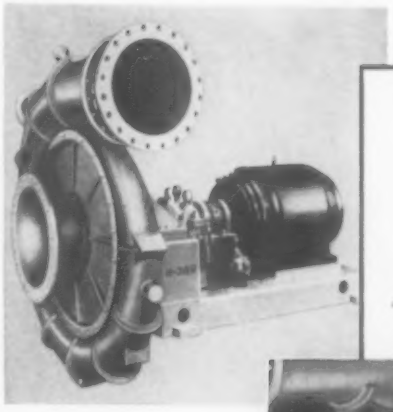
Portable Gasoline Plants Can Be Leased From Elsey

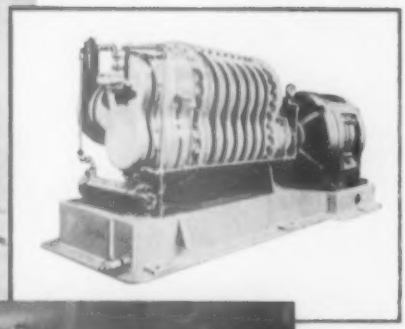
A new plan, which enables oil producers to lease skid-mounted gasoline plants instead of buying them outright, has been announced by C. A. Elsey, president of Elsey Corp. of Bartlesville, Okla.

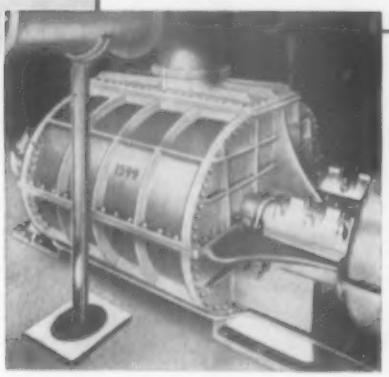
Under the plan, an oil producer may lease a plant of any capacity without any capital investment.

"This will enable the small producer, who has been unable to purchase a plant due to the large investment, to double and even triple the income from a given well without any capital outlay," stated Elsey. "In the case of the large producer it will free the capital for other ventures."

Built to the lessees' specifications and requirements, complete with com-







- Above: R-C Centrifugal Exhausters, in capacities up to 100,000 cfm.
- *Upper right:* R-C Spiraxial Compressors, from 700 cfm to 5,000 cfm.
- *Right:* R-C Rotary Positive Blowers, sized from 5 cfm to 50,000 cfm.

R-C *plur-ability* PAYS DIVIDENDS WHEN MOVING AIR OR GAS

Where quantity and quality of production depend upon the reliable, economical performance of blowers, exhausters and related equipment, look to the values of *R-C plur-ability*.

- choice of centrifugal, rotary positive and Spiraxial® types, an exclusive advantage of Roots-Connersville.
- accurate control of volume and pressure.
- ample choice of capacities, from 5 cfm to 100,000 cfm.
- high efficiencies and low operating costs.
- low down-time and maintenance expense.
- long-time durability.

All these factors add up to *R-C plur-ability*. They work for you in machines which you buy for your own use, or for resale with your equipment, where handling gas or air at moderate pressures is required. Our engineering experience and ability are at your service.

You'll find R-C plur-ability in all these products

Centrifugal and Rotary Positive Blowers, Gas Pumps and Exhausters

• • •

Spiraxial® Compressors

• • •

Positive Displacement Vacuum Pumps and Meters

• • •

Inert Gas Generators

• • •

Whether you use or sell equipment using gas or air at moderate pressures, check *R-C plur-ability*.

ROOTS-CONNERSVILLE BLOWER

A DIVISION OF DRESSER INDUSTRIES, INC.

1155 Oak Ave., Connersville, Indiana. In Canada—629 Adelaide St. W, Toronto, Ont.

Sargent

RODLESS PUMP pays off 25 to 1

"Before using Sargent, 19 hydraulic pumps averaged only 17 days each in this well. The Sargent Rodless Pump is still working efficiently after 426 days"

Such a margin may seem fantastic, but it's true. Actual well records show that 19 other hydraulic pumps averaged only 17 consecutive days each before having to be pulled and serviced. A Sargent Rodless Hydraulic Pump in the same well has continued uninterrupted operation at top pumping efficiency for 426 consecutive days *and is still operating*. That's the type of impressive performance that places the Sargent Rodless Pump in a class by itself. These same records show that this particular pump and hydraulic unit had an efficiency of 98% at the hydraulic engine and 92% at the pump. This unit has proved the best method of pumping oil and performs equally effectively in any type of well. This is not an exceptional case. In field after field, under widely varied well conditions, records prove Sargent lifts more oil at lower cost per barrel. Regardless of your pumping requirements, it will pay you to check the features and advantages that enable the Sargent Rodless Pump to get you more oil at lower cost. *Write today for complete details.*

CHECK THESE FEATURES:

The Sargent Rodless Hydraulic Pump places the long-stroke unit at the bottom of the well, where it is operated hydraulically without the need for sucker rods. Rod problems and tubing wear are thus entirely eliminated. Energized by crude oil under pressure (furnished by any suitable prime mover located at the surface), the pump requires minimum operating pressure for a given pumping depth and production capacity. Plunger bumping up and down is eliminated because the unit cannot overstroke or understroke. Pump valves are accurately spaced during assembly in the shop. The close spacing and long pump strokes yield the ultimate in gas compression ratio, thus reducing gas lock difficulties.

The pump unit can be surfaced merely by turning a valve and generally can be serviced right at the well. More than twenty Sargent Field Stores furnish standard Sargent API parts and pump service in the field.

SALES & SERVICE

CALIFORNIA
Long Beach
Bakersfield
Santa Maria
Ventura • Taft
Huntington Park

OKLAHOMA
Oklahoma City
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NEW MEXICO
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KANSAS
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ILLINOIS
Grayville

ARKANSAS
Magnolia

COLORADO
Rangely

Standard of Excellence — *Since 1920*

Sargent

ENGINEERING CORPORATION
2533 EAST 56TH STREET
HUNTINGTON PARK, CALIF.

"Good will" is the disposition of the pleased customer to return to the place where he has been well treated.
—U.S. Supreme Court

BUILDS PUMPS THAT BUILD GOOD WILL

pressors, the plants are exceptionally portable and can be used in multiples to get more production over a short period. Economical to operate and maintain, they are designed with a flexibility that permits them to meet changing conditions and requirements.

Halliburton Oil Well Advances C. M. Roberts

C. M. ROBERTS

Clint M. Roberts, veteran credit manager for Halliburton Oil Well Cementing Co., has been named assistant treasurer and general credit manager, Erle P. Halliburton, chairman of the company, has announced. The Halliburton executive began his career as a cementing truck driver in 1928 at Seminole, Okla. Moving to Halliburton's Duncan, Okla., headquarters in 1932, he has headed credit operations since.

I-H Names Sandford To Dallas Sales Post

Don B. Sandford has been appointed manufacturer sales representative, industrial power division, for International Harvester Co., covering Texas and Oklahoma. Sandford, a 21-year employe of International Harvester, is well known in field operations. His entire service with the company has been spent in engineering design and sales engineering. For the past 10 years he has been active in oil-field preparations.

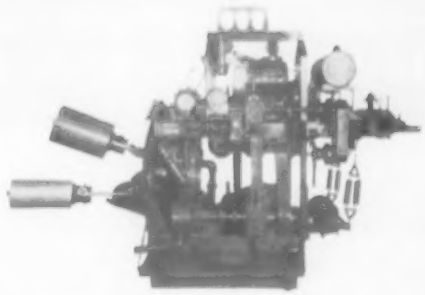
Sandford's headquarters are at the International Harvester district sales office, Dallas.

Alco Names AlcoPlate Product Manager

Appointment of William L. Clark as product manager of the company's AlcoPlate process has been announced by Alco Products, Inc. In this capacity Clark will be in charge of all phases of production, marketing, and research involved in the company's new method of chemical nickel plating. He will make his headquarters at Alco's Dunkirk, N. Y., plant.

Formerly chief metallurgical and chemical test engineer at Schenectady, Clark joined Alco in 1946 as a mem-

proved...
efficiency and durability
over miles of pipelining



- Coats high welds, wrinkled bends, egged pipe.
- Heated ring prevents dope from "freezing".
- Saves as much as 30% on dope.
- Built in strainer prevents foreign particles from getting to pipe surface.
- Available for all sizes of pipe.

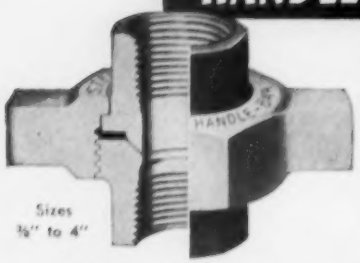
CROSE LINE TRAVELING
COATING AND WRAPPING MACHINE

The original spray-ring type coating machine assures positive and uniform coating of pipe. Available with rubber or steel crawler wheels that assure positive traction. Precision-built paper brakes are adjustable to permit perfect tension of paper. Wrapping head is driven by a variable speed gear box which enables the operator to control and maintain the proper lap of wrapping material. For the best in pipeline equipment — Specify CROSE!

M. J. Crose
Manufacturing Company, Inc.
2715 DAWSON ROAD • PHONE MAdison 6-3173 • TULSA, OKLAHOMA
15725 EAST COLFAX AVENUE, AURORA, COLORADO • 369 FIFTH AVENUE, NEW YORK CITY
DISTRIBUTORS:
CROSE-CURRAN LTD., EDMONTON • CROSE PIPELINE EQUIPMENT CO., INC., NEWARK, N. J.
PIPELINE SUPPLY CO., HOUSTON

PRESSURES AND TEMPERATURES are SAFE in these

"HANDLE-BAR" 4000 TEST



Sizes ⅛" to 4"

FORGED STEEL UNIONS

A skillfully engineered seat design provides the perfect seal for holding securely rated temperatures and pressures. Advanced manufacturing methods, rigidly controlled step by step to maintain the highest standard of quality, produce these accurately finished, rugged Handle-Bar Unions.

Quick and Easy to Make and Break because the nut threads are permanently lubricated with Udylite Cadmium. The Extra Heavy Nut provides the strength necessary to withstand rough handling and excessive abuse. So Great in Value . . . So Low in Cost.

WRITE TODAY FOR OUR FREE, NEW, COMPREHENSIVE CATALOG

Clayton Mark & Company

1900 DEMPSTER STREET · EVANSTON, ILLINOIS · U.S.A.

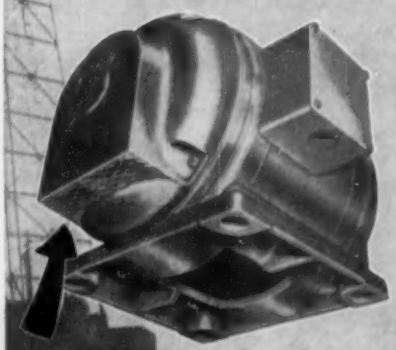
designed especially for *continuous* outdoor use . . .

FIELDMASTER BALL BEARING MOTORS

More and more FIELDMASTER Ball Bearing Motors are purchased for oil field use than ever before. Here's why: These **rugged** motors are **specially built** to meet the **tough** and **varied demands** of continuous outdoor use.

For example — heavy cast base assures alignment stability . . . heavy-duty, double-shielded, pre-lubricated bearings increase performance, reduce lubrication problems . . . high-grade silicon steel in the magnetic circuit reduces iron losses . . . wide variety of windings provides triple ratings, dual voltages . . . high torque licks heavy starting problems . . . high slip is available to take care of reciprocating load requirements encountered in pumping.

The FIELDMASTER has many other **outstanding advantages** that our distributor, the BETHLEHEM SUPPLY COMPANY, will be happy to show you. May we have them contact you . . . **without obligation?**



Screened Air Port Keeps Out Rodents!

VALLEY ELECTRIC CORP. 4221 FOREST PARK BLVD., ST. LOUIS, MO.

Distributor, BETHLEHEM SUPPLY CO., TULSA, OKLA.

ber of the company's junior engineering training program.

Mississippi River Fuel Launches Drilling Barge

The Roscoe Hobbs, first drilling barge of Natural Gas & Oil Co., a division of Mississippi River Fuel Corp., and named for a member of its board, slid down the way at Alexander's Shipyard recently for location at Natural-Humble No. 1 Albert S. Rawle in the Kings Ridge field, Lafouche Parish, Louisiana.

To be operated by H. L. Rowley, Inc., drilling contractors, the 165-ft.-long, 46-ft.-wide barge has been designed to correlate the most advanced marine construction and oil-rig engineering and equipment.

Laid out for maximum efficiency beneath the new Lee C. Moore 960,000-lb.-capacity, 136-ft. derrick is an Oilwell 96 draw works powered by two GM quad diesel engines totaling 1,300 hp. Another GM quad operates an Oilwell 20-in. mud pump. The other Oilwell mud pumps, a 20-in. and 14-in., are operated from the compound.

An electrically driven conveyor carries dry mud from the service boat to the storage room where another conveyor takes the mud to mixing tanks forward and on the starboard side. Mud pumps are equipped with high speed electric mixers as well as conventional guns.

The rig is designed to mount an additional 300 hp. GM twin six at the compound, permitting the replacement of the 14-in. pump with a larger unit. With provision for another GM twin six diesel to drive the rotary table independently, the rig would have the power necessary to handle work at 20,000-ft. depths.

Philadelphia Gear Names Davies Asst. Sales Head

Peter B. Davies has been appointed assistant sales manager of Philadelphia Gear Works. This is a new position with the company, created to meet the growth of sales volume in all product

MOUNTAIN STATES PRODUCER

saves $50,000

IN DRILLING ONE HOLE

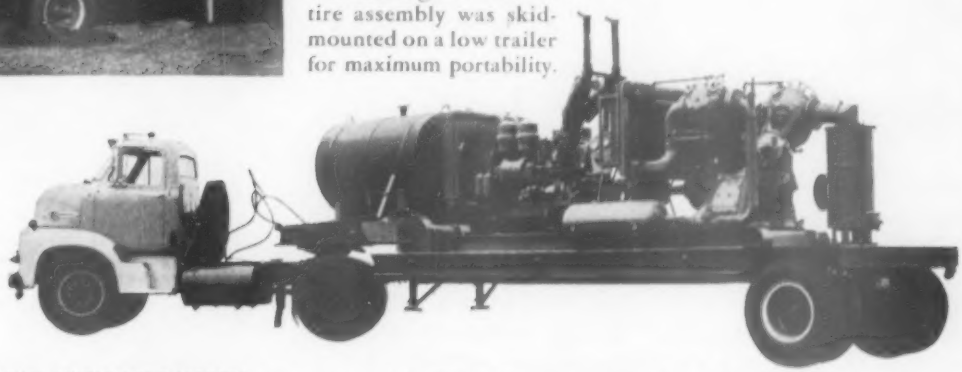
DRILLING WITH AIR DID THE TRICK Average production depth for wells in this Mountain States area is 4,000 ft. Simply by changing from mud drilling to air, this producer reduced his drilling time drastically:

LOOK AT THESE FIGURES!

MUD DRILLING (Average 4000' hole)	AIR DRILLING (Average 4000' hole)
Time required.....47 days	Time required.....56 hours
Bits used.....47	(Actual drilling time—47 hours)
Cost of mud used.....$14,000	Bits used.....1

DRILLING WAS ON CONTRACT BASIS Rig time was charged on a per day basis. The reduced rig time and bit costs, outlined above, *produced savings of 80%*, or $50,000.

JOY WN-102'S FURNISHED AIR Each self-contained, heavy-duty, water-cooled, double-acting compressor—for pressures up to 250 psi—was direct-connected to a diesel engine. The entire assembly was skid-mounted on a low trailer for maximum portability.



OTHER COMPRESSOR MODELS Joy can furnish WN-102 compressors as twin units. Two units are driven through a single pulley which is belted to the drill rig engine. Joy also produces a complete line of portable compressors which are outstanding performers for both air and gas drilling.

Write today for complete information on these top-performing compressor units manufactured by the pioneer of rotary air-blast drilling . . . ***Joy Manufacturing Company, Oliver Building, Pittsburgh 22, Pa.*** In Canada: *Joy Manufacturing Company (Canada) Limited, Galt, Ontario.*

Write for FREE Bulletin 20-31

Consult a Joy Engineer

FOR AIR COMPRESSORS • MOTORIZED DRILL RIGS
GAS GATHERING COMPRESSORS
PORTABLE LIGHTING LINES

JOY

SPECIALISTS IN THE COMPRESSION AND MOVEMENT OF AIR AND GASES SINCE 1885

W&D 05848-20

New *from* ***INTERNATIONAL...***

New "go-anywhere" light-duty 4-wheel drive truck!

Here's the four-wheel-drive truck you've been waiting for! Here's a full-size, all-purpose truck you can use to go anywhere.

On or off the road, this new INTERNATIONAL S-120(4x4) will take the toughest grades in stride—fully loaded, it will move entire 7,000 lbs. of truck, body and cargo through soft sand, mud or snow. It's made to match all light-duty 4x4 jobs *exactly* with choice of 2 engines, 3 pickup and 2 stake bodies. Has exclusive INTERNATIONAL power take-off transfer case, plus optional power take-off transmissions for auxiliary equipment operation, is available in 6 tire sizes, including 7:00x18 for extra clearance and 9:00x16 for extra flotation and traction.

This newest INTERNATIONAL is all-truck built for rough, tough four-wheel-drive service . . . built to save you the BIG money, the operation and maintenance money. Before you buy any light-duty 4x4 truck, see and drive this one at your INTERNATIONAL Dealer or Branch!

INTERNATIONAL HARVESTER COMPANY • CHICAGO

A Complete Line of Light and Medium 4x4s for Every Tough Job Need

S-140(4x4). 11,000 lbs. GVW. Has 4-speed transmission and 2-speed transfer case, for 8 forward and 2 reverse speeds. 2 transmission power take-offs. Provision for third on transfer case.

S-160(4x4). 15,000 lbs. GVW. Has same transmission and transfer case as S-140 model, and like S-140 and S-120 has famous full-size Comfo-Vision cab and exclusive INTERNATIONAL features for easiest four-wheel-drive steering and handling.

INTERNATIONAL® TRUCKS

All-Truck Built to save you the BIG money!

Motor Trucks • Crawler Tractors • Industrial Power • McCormick® Farm Equipment and Farmall® Tractors

lines. Davies has been a sales engineer with Phillie Gear since 1948.

Davies' new assignment will include sales administration of Philadelphia gears, gear reducers, Sphereflex couplings, fluid agitators, and LimiTorque valve controls.

Felts, Hanson Named B & W District Managers

Jud L. Felts and Morgan Hanson have been appointed district managers by B & W, Inc., Houston, manufacturers of scratchers and centralizers.

Felts, who transferred from Harvey, La., is B & W's new manager for its eastern district, covering north and south Louisiana, eastern Texas, Arkansas, and Mississippi.

J. L. FELTS

M. HANSON

Hanson, who transferred from Abilene, Tex., will manage the western district, covering north and west Texas, New Mexico, and the Rocky Mountain area.

Felts and Hanson will work in Houston under the supervision of L. D. Styles, Jr., sales-service manager of B & W, Inc.

Welex Jet Names Lewis As Great Bend Sales Engineer

Joe P. Lewis has been appointed sales engineer for the Great Bend, Kans., district office of Welex Jet Services, Inc., the oil-well service company has announced.

Lewis has been with Welex for 2 years and worked as a rigger and a shooter for the company before starting in sales work.

Marvel Engineering Moves To New Chicago Facilities

Marvel Engineering Co., designers and manufacturers of synclinal filters, has moved to its own, recently completed plant in Chicago. The one-story building of modern construction and design is situated on the company's grounds in such a way as to allow for further expansion when necessary. Plant layout and production lines are geared to greater efficiency.

Enlarged designing and engineering

Why
this Jam-Proof 65R
RIDGID
is most pipe threader for your money

Easiest to Use... Threads 1", 1¼", 1½" and 2" pipe and conduit with 1 set of chasers that adjust to size in 10 seconds. Mistake-proof self-centering workholder sets instantly to size. Threader can't jam—it kicks out automatically when standard length thread is cut. Unbeatable speed, least work.

Perfect Threads... 65R cuts beautiful threads—and you find the factory test sample in your new die stock to prove it. No other threader gives you as much for your money.

Ask to see the 65R at your Supply House. Try it, buy it—
it's a bargain in satisfaction.

The Ridge Tool Company • Elyria, Ohio, U. S. A.

RIDGID
Work-Saver Pipe Tools

Ciment Fondu is a high quality high-alumina cement and its manufacturers, Lafarge Aluminous Cement Co. Ltd. are by far the largest individual producers in the World. The name of Lafarge has been associated with the manufacture of lime and cements for 125 years and Ciment Fondu is to-day in continuous use throughout industry on all five continents. This proud record is maintained through a combination of long experience, manufacturing know-how and a determination to remain acknowledged as producers of The Best Cement in the World.

CIMENT FONDU

Speed, Strength, Resistance, Refractoriness

No other type of cement combines all these advantages. High-Alumina is stronger —hardens more rapidly. For many purposes concrete can safely be put into use within a few hours of placing and is ready for any purpose in 24 hours. High-Alumina is completely immune from attack by sulphates and highly resistant to sulphuric acids. High-Alumina produces Refractory Concrete stable to 2500°F., Non-spalling; Non-shrinking.

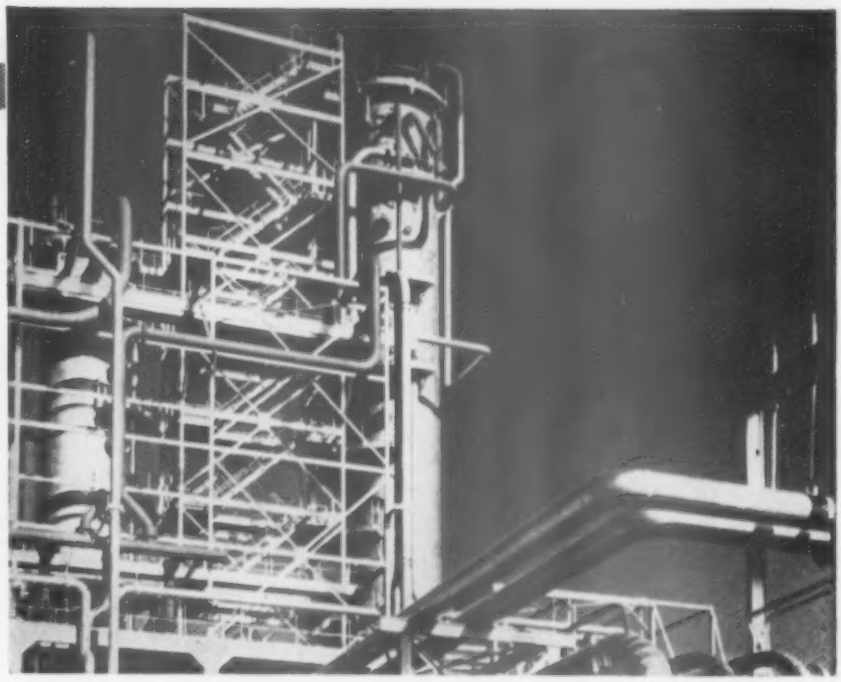
CIMENT FONDU is available throughout the World in any standard bag or steel drum.

Special uses for the Oil Industry include :—

Internal insulation of regenerators
Lining flash columns in cracking plants
Lining tower shell in cracking plants
Lining reaction vessels
Piles
Burner blocks etc.
Filling Drilling shoes
Flare tips
Lining vacuum condenser receiver drums
Lining cone section of vacuum tower
Lining barometric condenser at bench
Lining fractionating towers
Lining overhead receivers at stabilisers
Linings for protecting steel in bubble towers and vaporisers
Facing of tube sheets (insulating concrete) in oil still furnaces
Retaining safety walls in Refractory Concrete scrubber linings
Heat resistant foundations and hearths and floors
Furnace flues: ducts: stacks
Vermiculite/C.F. for spraying furnace stanchions
Mortar for brick laying
Tank and pipe linings to protect against sour crudes

ABRIDGED LIST OF PLANTS IN WHICH CIMENT FONDU HAS BEEN USED :—

Aden Petroleum Refinery Ltd., Aden.
Anglo Egyptian Oilfields Ltd., Suez.
Assam Oil Co. Ltd., Digboi Refinery, India.
Arabian American Oil Co., Saudi Arabia.
Australian Oil Refining Ltd., Kurwell Refinery, Sydney.
Australasian Petroleum Refinery Ltd., Kwinana.
Bahrein Petroleum Co. Ltd., Bahrein.
Basrah Petroleum Co. Ltd., Basrah, Iraq.
Berry Wiggins & Co. Ltd., Kingsnorth Refinery.
Burmah Shell Refineries Ltd., Bombay, India.
B.P. Benzin-und Petroleum - G.m.b.H. Refinery, Hamburg.
Caltex Petroleum Maatschappij, Rotterdam.
Canadian Petrofina Ltd., Montreal, Quebec.
Compania Shell de Venezuela Ltd., Cardon Refinery.
Consolidated Oil Refineries Ltd., Haifa.
Diadema Argentina S.A. de Petroleo, Buenos Aires.



for the OIL INDUSTRY

Esso Petroleum Co. Ltd., Fawley Refinery.
Grangemouth Petroleum Refinery Ltd., Grangemouth.
Imperial Oil Co. Ltd., Ontario, Canada.
Industria Raffinazione Olii Minerali, S.P.A. Porto Marghera, Venice.
Iraq Petroleum Co. Ltd., Iraq.
Iranian National Oil Co. Ltd., Abadan.
Kent Oil Refinery Ltd., Isle of Grain.
Lobitos Oilfields Ltd., Ellesmere Port.
McColl Frontenac Oil Co., Montreal, Quebec.
Manchester Oil Refinery Ltd., Trafford Park.
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N.V. de Bataafsche Petroleum Mij, Balik Papan, Indonesia.
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Sarawak Oilfields Ltd., Labuan, Borneo.
Shell Co. of Australia Ltd., Geelong Refinery.
"Shell" Refining and Marketing Co. Ltd., Shellhaven.
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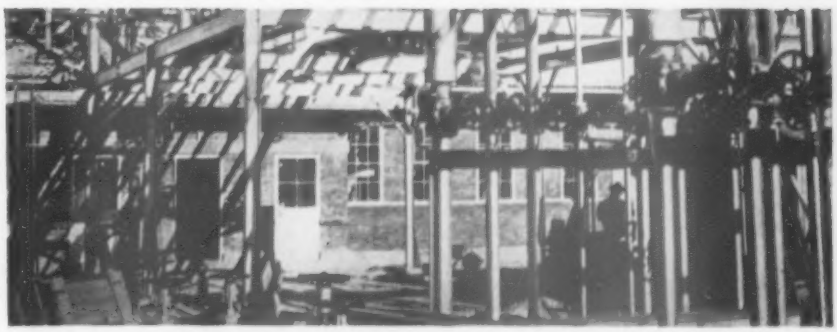
Standard Oil Co. of British Columbia, Vancouver.
Trinidad Leaseholds Ltd., Trinidad.
Vacuum Oil Co. Ltd., Coryton Refinery.



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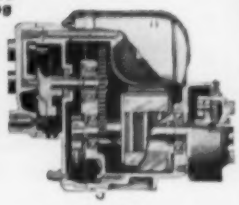

This is type FM-XOR six cylinder magneto with ball bearings throughout—available in base or flange mounting.

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departments are fully equipped and staffed to facilitate the company's constant research for the improvement of filtration of hydraulic oils and other liquids in low-pressure circulating systems.

Jones & Laughlin Breaks Ground for Headquarters

Ground for the new $1,500,000 headquarters building for Jones & Laughlin Steel Corp. supply division was broken in Tulsa November 2. Officials participating in the ceremonies included Tulsa Mayor L. C. Clark; Rainey Elliott, Tulsa, president, J&L supply division; John E. Timberlake, Pittsburgh, vice president, sales, for J&L; and C. L. Austin, Pittsburgh, J&L president. The new building is expected to be completed in September 1956.

Hudson-Rush Opens New Amarillo Office

Hudson - Rush Co., manufacturers' representatives, with offices in Dallas and Shreveport, has opened an office in Amarillo, Tex., to serve the Texas-Oklahoma Panhandle.

Wayne Griffiths will head the Amarillo district office. He was formerly a sales engineer in the Amarillo area for one of the leading representatives of industrial control and instrument equipment.

Walworth Purchases Southwest Fabricating

Purchase of the assets and business of Southwest Fabricating & Welding Co., Inc., Houston pipe - fabricating company, by the Walworth Co. has been announced.

Fred W. Belz, president of Walworth, manufacturers of valves and pipe fittings, announced that 107,039 shares of common stock of Walworth were exchanged for Southwest Fabricating.

Southwest Fabricating supplies important markets throughout the world in the oil, chemical, petrochemical, and

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- *Using indirect heat transfer mediums, including molten metal, molten salt, Dowtherm, mineral oil and other fluids*

The rich-oil heater illustrated is installed in a gas processing plant in Oklahoma, having a capacity of approximately 60,000,000 standard cubic feet per day. A special coil installed in the heater is used to superheat the steam from oil-field-type boilers installed nearby.

This heater is typical of hundreds of similar units installed in gasoline plants, petroleum refineries, chemical plants and for a wide range of services. Equipment is in service to the highest commercial temperatures.

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natural gas fields. Belz said Southwest will be operated as a subsidiary of Walworth, retaining present management and employes and continuing present policy.

Walworth recently completed the purchase of two additional important manufacturing companies, M & H Valve & Fittings Co., Anniston, Ala., and Alloy Steel Products Co., Linden, N. J. These acquisitions are part of Walworth's planned expansion and diversification program.

GSI Purchases Rogers Exploration Service, Ltd.

Purchase of Rogers Exploration Service, Ltd., of Calgary, Alta., by Geophysical Service, Inc., Dallas, has been announced by GSI President Cecil H. Green. Terms of the purchase were not disclosed.

Rogers Exploration Service, Ltd., has been furnishing gravity-exploration service to the Canadian petroleum industry since 1949. Prior to this date, the firm had been operating in the United States since 1946. The company currently has three gravity-meter field parties under contract to oil companies operating in Canada.

C. M. Moore, Jr., president of GSI's Canadian affiliate, Geophysical Service International Corp., with headquarters in Calgary, will assume presidency of the Rogers firm. Former owner, John O. Rogers, will remain with the company in a supervisory capacity.

Geophysical Service, Inc., and its foreign affiliate companies form the exploration service division of Texas Instruments, Inc., Dallas manufacturer of transistors, semiconductor products, and electric equipment.

Big Unibolt Couplings to Go on Offshore Platform

This is a photograph of one of eight 42-in. o.d., A.S.A. 600, Unibolt couplings being manufactured by Thornhill-Craver Co. of Houston for Joe Stine, Inc., Houston. The big couplings are equipped with blanking plugs and will be used instead of blind flanges to close the ends of hydraulic cylinders that are being fabricated by Stine for an offshore drilling platform. The Unibolt coupling with blanking plug weighs approximately 40 per cent less than a flanged closure of the same A.S.A. 600 rating.

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Composed of only two parts, the body and the babbit socket, the Ratigan #142 Stringing Up Link is a safe, fast acting link. It eliminates looping and bending of the cable, and tightening of the bulldog clamps.

An automatic safety pin prevents the socket from escaping the body until the pin is removed and the bail opened.

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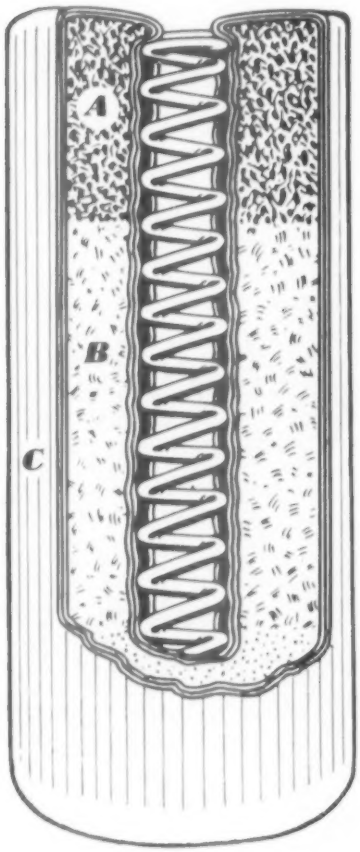
COMPLETE OIL FILTRATION IS NEVER SIMPLE

by CHARLES A. WINSLOW

Conditions under which most industrial engines operate may introduce grit, sludge, acid or moisture into lubricating oil. To remove these engine-destroying materials requires FULL FLOW filtration under cold and hot operations, without incurring back pressures, and with complete protection to critical surfaces in case of any part failure. Contaminants must be removed without affecting additives.

This complete protection for lubricants is not simple. It can best be accomplished with the four materials combined in Winslow CP* Elements. These elements are also designed for definite and predictable flow and pressure characteristics. When they are correctly applied, the oil is *all* filtered under *all operating conditions*, through these successive steps:



(A) CP* Material accepts varying percentages of oil flow, to maintain acceptable pressure.

(B) Combined thread and cellulose absorbs moisture and gums.

(C) The patented outside wrapper is an effective filtering medium.

CP* Material Gives Automatic Pressure Control

The specially treated CP material accepts varying percentages of the total oil flow, as conditions dictate; thus maintains acceptable pressure losses without opening by-pass valves, and insures 100% Full Flow filtration at all times. All harmful particles are removed from the oil.*

Cotton Thread Combined With Cellulose Fibre

The cotton thread is porous and fluffy for full dirt retention, and creates a multitude of intricate passages to catch minute particles. It is combined with clean, dry cellulose fibre, which prevents packing and channeling of the filtering media. This selected fibre also absorbs gums, moisture and varnish that may be present in the oil.

The fourth filtering media is the patented double wrap of tubular cotton on both the inside and outside of the Winslow element.

Proportion of Materials Determines Pressure

In a Winslow CP* Element the ratio of filter materials determines the rate of oil flow through the element. This ratio is set for each size and type CP* element, based on laboratory and field tests.

Element Packed for Progressive Filtration

Each Winslow CP* Element has the same amount of material at the outer area as there is near the center. Obviously the material is more condensed at the center. This forms V-shaped traps for progressively smaller particles, increasing the capacity and useful life of the element. The tubular cover is also squeezed tighter at the center and is more open at the outside.

This combination of exclusive Winslow features and materials has been proved for years, under severe engine service, to be the most efficient and in the long run, the most economical method of lube oil filtration. We will be glad to give you complete data on filters and elements for your equipment. Please write or call the nearest office.

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½ inch through 42 inches . . .

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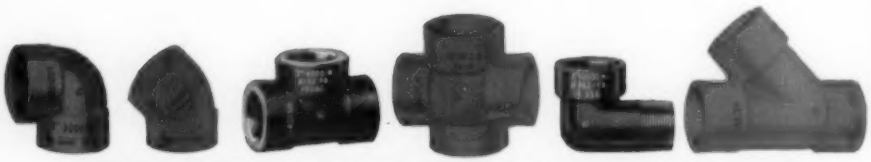
½ inch through 24 inches . . .



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⅛ inch through 4 inches . . .

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up to 24 inches, 150 lb. through 2500 lb.

Complete Service . . .

BUTT WELDING FITTINGS

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McCullough M-3 Guns Gain 760 B/D

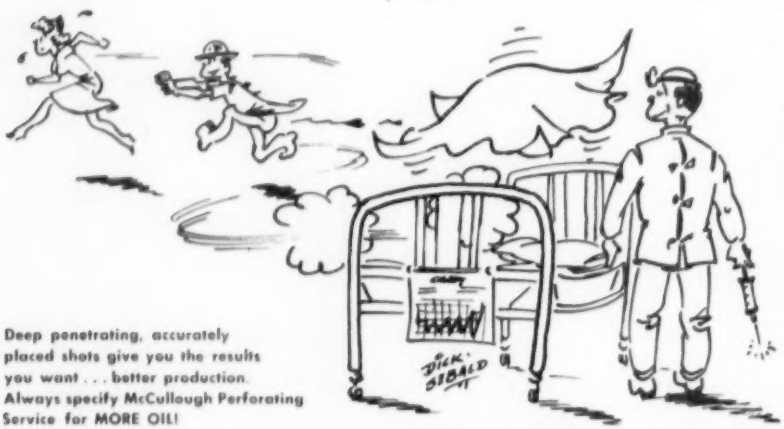
Previous Attempt Failed To Get Penetration

Powerful McCullough M-3 Guns firing improved Ogival Bullets again proved their superior penetrating power in a recent job in this Texas well.

The well had first been perforated by another service company, but the operator was unable to break the formation down under 3500 pounds pump pressure.

Depth of operation was 9800'. 5½" O.D., 17 lb. casing had been cemented through the pay zone.

McCullough 4¾" O.D., 30-shot M-3 Perforators fired 84 improved ½" Ogival Bullets in the same interval previously perforated. The formation broke down at 1200 pounds pump pressure. After treating, the well made 760 barrels of oil per day—the best well in the field.



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M-3 Guns Shoot 400 Holes in 73° Angle Well in Two Runs

Unusual Perforating Job Could Only Be Accomplished By Simultaneous Firing, Deep Penetrating McCullough M-3 Bullet Perforators

While unusual jobs such as this occur only infrequently, they serve to demonstrate the ability of McCullough Perforating Services to accomplish the tough jobs with the same speed, economy and satisfaction that characterize ordinary operations.

This well was directionally drilled from an onshore location out under the ocean bed. Due to the high degree angle of the well (73°) it was impossible to perforate by regular electric wire line methods.

8⅝" O.D., 36 lb. casing had been cemented in 12¼" hole. The interval to be perforated was from 6696' to 6796'.

Ten 4¾" O.D., 20-shot McCullough M-3 Guns (50') were screwed together and run in on 4½" F. H. drill pipe. A swab cup was arranged on a 1¾" O.D. probe, attached to the electric wire line and pumped down the drill pipe until it contacted a firing sub attached to the top of the guns.

Two sets of M-3 Guns of the above length were run, firing 400 ½" improved Ogival Bullets in the 100' zone. The entire job took only 26 hours to complete which included two round trips with the drill pipe and two runs with the probe. No trouble, no delay was experienced. The job was satisfactory in every respect.

Only McCullough M-3 Guns, firing all shots at one time, could successfully complete this unusual job. In addition, deep penetration through heavy casing cemented in large diameter hole was assured by the extra power of M-3 Guns firing improved Ogival Bullets—hardest shooting bullet perforators in the world.

Literature Available on McCullough M-3 Bullet Perforators

1. **Four-page illustrated bulletin, No. 203, gives advantages, characteristics, etc. of M-3 Bullet Perforators and improved Ogival Bullets.**
2. **Sixteen-page pocket brochure tells benefits of M-3 Perforators, supplemented by actual job reports.**

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EXPLORATION

Rockies Score Once, Fumble Once

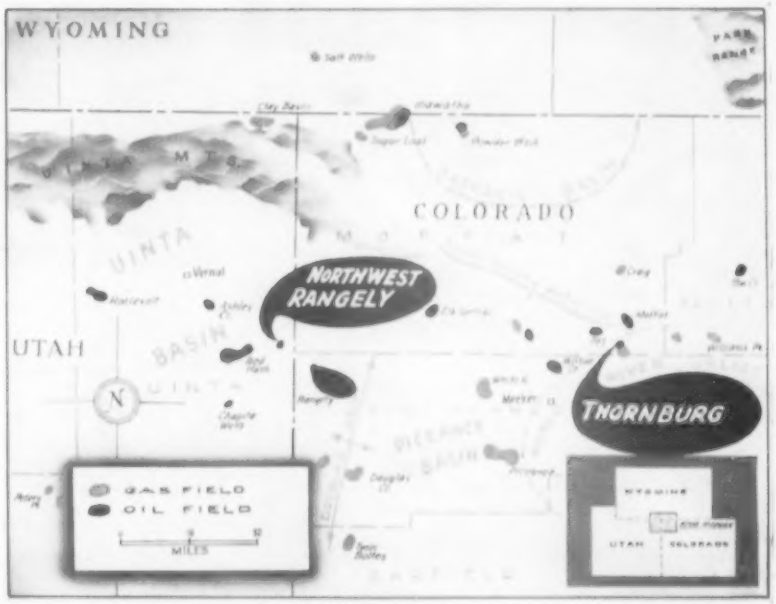
by Frank J. Gardner

TWO interesting strikes 75 miles apart in the Colorado-Wyoming-Utah tri-state corner held the attention of Rocky Mountain oil men the past week. One, reporting a 50-bbl. per hour flow, could open a new field and a new pay for the Uinta basin. The other, with excellent test recoveries, opens the first commercial oil pool on a 30-year-old gas-producing dome.

At Northwest Rangely, or "Raven's Ridge," depending upon whose map you use, New World Oil, Inc. I Taylor Government (Section 3-7s-25e, Uintah County, Utah) was spudded in just a year ago, on November 16, 1954. The well lies 3 miles west of the Utah-Colorado state line and 10 miles northwest of Rangely, the Rockies' largest oil field. After reaching total depth 10,432 ft. in Weber-Pennsylvanian topped at 10,320 ft., operators plugged back to 7,735 ft. and ran drill-stem tests in the Dakota-Cretaceous sand at 7,568-75 ft. Here, a flow of 40 to 50 bbl. of 44°-gravity oil per hour plus 1,500 M.c.f. gas per day was reported, using a 1¼-in. choke. Rocky Mountain observers hailed it as a major strike.

Oil to water . . . But this week, enthusiasm waned. The oil flow turned to water, a not uncommon phenomenon in Dakota operations. New World is squeezing the tested interval and will test at other levels. Early reports credited the test with shows in the Morrison-Jurassic, topped at 7,625 ft., and new tests here and in the Dakota may eventually commercialize the well, but at the moment its fate hangs precariously in the balance. The wildcat lies on the eastern edge of the Uinta basin, and if successful in the Dakota, would be the first Uinta well to produce from those rocks. Most Uinta oil comes from the Green River-Tertiary beds. The nearest Dakota wells are producing gas at Douglas Creek on the west edge of the Piceance basin (see map).

And gas to oil . . . More important from a discovery standpoint, probably, is the indicated oil strike on the north flank of Thornburg dome in Moffat County, Colorado. Here, Sinclair Oil & Gas Co. and Continental Oil Co. have run successful tests at their 3-A Unit to open the first commercial oil pool on this old gas structure. Located in Section 8-3n-91w, this new pay strike recovered 3,640 ft. of 25.4°-gravity oil and 200 ft. of oil and gas-cut mud on drill-stem test of the Weber-Pennsylvanian sand at 4,260-4,382 ft. At last report, operators were running casing for final completion.



Two Rocky Mountain wells, one at Thornburg dome in Colorado, and one at Northwest Rangely in eastern Utah, attracted industry attention last week. The Thornburg test opens first oil on that old dome. The Utah well is having serious water troubles.

Previously, the Weber at Thornburg had produced only gas—in a single well drilled by Continental in 1951. It was shut in after gaging 11,200 M.c.f. per day. A currently active test, Sinclair-Continental 2 Unit (Section 16-3n-91w), ¾ mile southeast of the new oiler, also has found Weber gas on tests at 4,017-55, 4,246-4,325, and 4,238-4,317 ft. This well, a pre-Jurassic test, is still in the testing stage at 4,546 ft.

May change a prospect . . . Thornburg dome is a large ovate uplift with 800 ft. of structural closure covering some 3,400 acres on the Moffat-Garfield county line. It is 2 miles wide and 3½ miles long, with the axial trend northwest-southeast. It lies at the southeastern extremity of the regional Axial Basin anticline, and on the northern edge of the White River uplift (see map). Gas was discovered here in 1925 in the Dakota at 2,000 ft., but only two wells were finished as producers. Later, in 1936, gas was found in a single Sundance (Entrada-Jurassic) well at 2,600 ft. Continental's Weber gasser was the fourth successful well on the structure in 1951.

Here is an example of what may be expected from Colorado's neglected prospects in the future. The finding of Weber oil at Thornburg may presage the conversion of this large dome into a real oil producer. The big difficulty will be porosity and permeability factors, a well-known Weber problem. Continental's Weber gas discovery had only 4.4 per cent porosity and 0.6 md. permeability. The same problem was found at Rangely, where prolific Weber oil production comes from a sand with 16 per cent porosity and 20 md. permeability. But Rangely producers have held up well, and if the problem can be licked at Thornburg, some excellent oil development might well be expected there.

For major oil . . . The development pattern at Rangely, where oil was first found in 1902, lagged along until 1943, when real drilling and development of the Weber reservoir zoomed the field into major status. Are we witnessing a similar pattern on the smaller but just-as-promising Thornburg dome?

12 RED HOT REASONS

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1. PGAC's standard core gun retrieves up to 32 separately-fired barrels with cores from 1 to 32 zones — on one trip in your well.
2. More good cores consistently recovered by PGAC than by any other gun — **proved** in thousands of wells cored.
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4. For optimum core recovery, PGAC varies the powder-charges according to the hardness of your formation.
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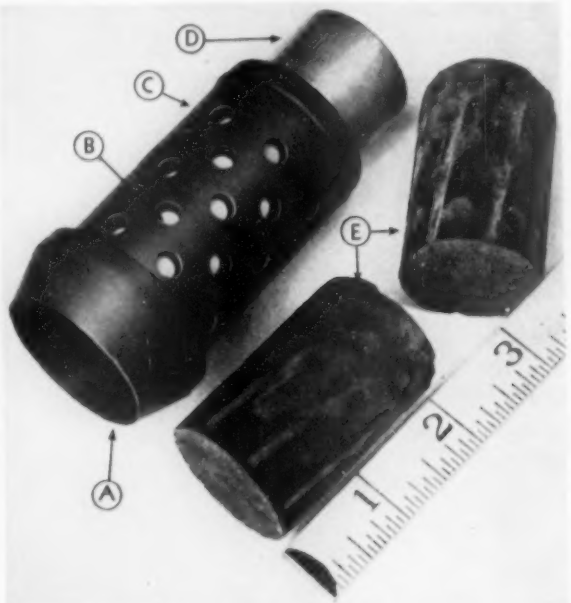
6. Removable cutter-heads, of exclusive PGAC design, are automatically sheared from barrels and left in formation — for easier withdrawal of barrels and cores from your sidewall.
7. PGAC's flexible steel barrel-retrieving cable, of 2800-lb. tensile strength, assures barrel and sample recovery.
8. The Jumbo core gun is positioned in your formation with exceptional precision by the S.P. curve on PGAC's electrical log.
9. PGAC's surface indicator responds as each barrel is fired — eliminates re-runs in well because of undisclosed misfires.
10. Foolproof PGAC safety features prevent accidental firing — assure intentional firing only.
11. Subsequent completion operations have never been complicated by barrels or other debris left in a well cored by PGAC.
12. PGAC's Jumbo coring operation is simple, fast, certain, economical — and always ready to serve you.

PGAC 561



(Right) PGAC's 32-shot Jumbo sidewall coring tool.

(Above) PGAC sidewall coring projectile and cores: A — Cutter; B — Mud extrusion ports; C — Core barrels; D — Powder chamber and retrieving cable housing; E — Large PGAC Jumbo Cores.

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ALONG Louisiana's Miocene trend, geologists consider that dip closure practically assures production. Fig. 1.

Condemned Prospects Challenge Geologists

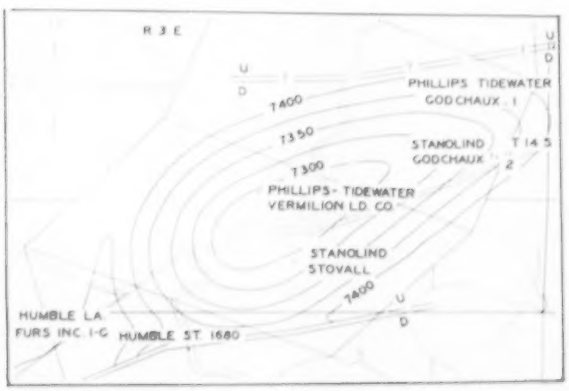
Here are four examples of prolific fields that were discovered by subsurface geology after early wells had "proved" them dry

by Owen C. Brown

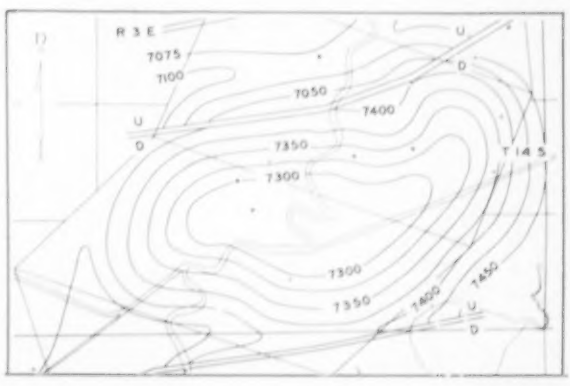
SOUTH LOUISIANA has in recent years emerged as one of the most attractive areas for oil exploration in this country. The rather belated realization of the potentialities of this oil province has prompted many companies to move into the area and pour a tremendous amount of money into South Louisiana exploration.

Since most of these companies have seen fit to hire experienced South Louisiana personnel, it is obvious that they recognize that the area has its own particular problems. However, it is the writer's opinion that the full potential of the work of an imaginative, experienced South Louisiana geologist is not fully recognized by the majority of both new and firmly established companies in the South Louisiana area. It

Author is with Seaboard Oil Co., New Orleans, La. This is an abridged version of a paper that appears in Transactions of the Gulf Coast Association of Petroleum Geologists, Vol. 5, October 1955, pp. 97-112. In the original version, the author discussed five examples—Live Oak, Franklin, East Lake Palourde and Amelia, Kent Bayou, and Turtle Bayou, and Bourg.



BEFORE development drilling, several dry holes apparently had condemned the Live Oak structure. Fig. 2A.



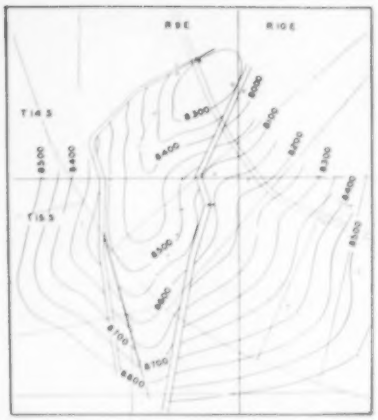
AFTER production, Live Oak field bears a close resemblance to Fig. 2A. Fig. 2B.

is the purpose of this paper to point out by several illustrations the results which have been obtained recently by the simple direct approach of subsurface geologic methods.

Three subsurface prospects which have proven productive during the past 6 years have been chosen as examples (Fig. 1). All of these prospects are now producing and they represent prolific oil and/or gas pools. These prospects fall within the Miocene trend and can be mapped on one horizon by the subsurface geologist as he works a single Tobin strip.

The reservoir stratigraphy along this entire trend is excellent. Production is usually found between the Bigenerina humblei-Siphonina davisi markers. All of these structures are probably the result of deep-seated salt movement. Let's now examine these prospects briefly as they developed from nebulous subsurface leads into producing fields.

BEFORE development drilling, Franklin appeared to be a fairly simple structure. Fig. 3A.



AFTER development drilling, the Franklin structure proved to be complexly faulted. Fig. 3B.

Live Oak field . . . This field is the westernmost of the areas. It is located in southeastern Vermilion Parish just north of Vermilion Bay. This prospect first drew drilling activity in January of 1937 when Stanolind Oil & Gas Co. plugged the 1 Stovall. A second Stanolind test, the 2 Stovall, located about 2 miles to the northeast, was abandoned in October 1938. Although this second venture was carried to only 8,004 ft., it gave strong indications of an anomaly because of its lower structural position than that of the first well. This was despite the fact that it was located in a regionally updip direction (Fig. 2A).

There was no further drilling activity until 1944 when Phillips completed two unsuccessful tests. Both of these wells emphasized the anomalous condition of the area; they showed 10 ft. of north dip north of the Stanolind 2 Godchaux, and an abnormally flat condition between the Phillips 1 Vermilion Land Co. and the Stanolind 1 Godchaux. In addition, there was some indication of faulting deep in the Phillips 1 Godchaux, but this fault could not be confirmed with the available control.

In 1951, Humble drilled three unsuccessful wildcats south and west of the aforementioned tests. Subsurface data from these wells indicated an east-west-trending "down-to-the-south" fault south of the Stanolind and Phillips wells. Other than the fault, these wells did little to change the subsurface picture of the prospect to the north.

The discovery well for Like Oak field was completed in February 1954 when the Houston Oil-Seaboard Oil 1 Godchaux was completed as an oil well from perforations at 12,334 to 12,340 ft. The discovery well and subsequent drilling have proven the suspected faulting in the Phillips 1 Godchaux and a third fault which lies to the north.

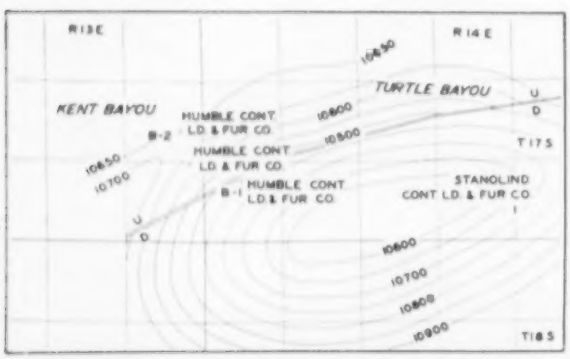
None of the prediscovery wells were drilled deep enough to reach the principal producing sands. Moreover, all of these wells, with the exception of the Phillips 1 Godchaux, are on the downside of the central fault. To date, all production lies on the upside of this fault (Fig. 2B).

The early wells are located very near the crest of the structure and give evidence of accurate seismic control. Nevertheless, it remained for a later operator to try the upside of the fault and to investigate a deeper section. Live Oak field is an excellent example of how an operator may drill a 12,500-ft. well on good seismic information and still miss an extensive field.

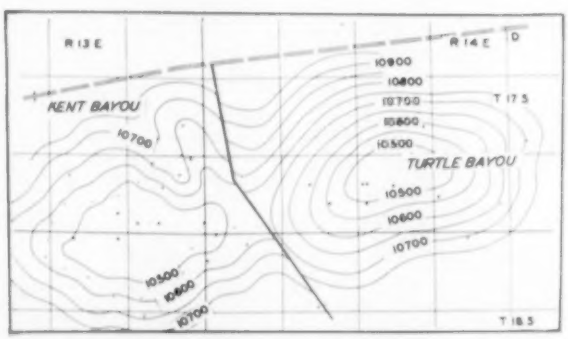
Franklin field . . . This pool is located in north central St. Mary Parish. It is 36 miles east and about 1,000 ft. downdip regionally from Live Oak. The stratigraphy here is somewhat more attractive than at Live Oak due to the presence of more shale in the Lower Miocene, which affords better seals.

Bateman Drilling Co. drilled the initial test at Franklin in 1941 (Fig. 3A). This unsuccessful venture cut a 280-ft. fault at 8,900 ft., which was proven by later drilling. Good shows were encountered in this well, and the operator made several unsuccessful drill tests of these zones.

The area attracted no further drilling activity until 1948 when Gulf drilled two tests, one to the northeast



BEFORE development drilling, Kent Bayou and Turtle Bayou were mapped as one structure. Fig. 4A.



AFTER development drilling, Kent Bayou and Turtle Bayou appear as separate closures. Fig. 4B.

and a second to the southwest of the Bateman well. The later well encountered a 250-ft. cutout at 7,200 ft., thus indicating that the fault in the Bateman well dipped to the northeast.

The Gulf 1 Foster, which falls northeast of the Bateman well, was structurally high and had several interesting shows. The aforementioned fault cuts this well at 11,400 ft., but because of the absence of nearby deep wells, this fault was not generally recognized until later.

Also in 1948, Sparta Drilling Co. drilled two wells to the southeast (the No. 1 well was junked at 1,859 ft.). The second Sparta well appeared to be structurally high, but no shows were reported. The next two ventures in the area (the Southern Six 3 Foster in 1950 and The California Co. 1 Fairfax-Foster-Bailey in 1952) were definitely off structure and confirmed southwest dip from the Gulf 2 Foster and southeast dip from the Sparta Drilling Co. 2 Foster.

At this point, there were two interpretations of the data that were held by most interested companies. Fig. 3A represents one of the prevailing ideas. The other interpretation ran the fault in an east-west direction, but showed the crest of the structure in roughly the same position.

After six previous tests had set up this prospect, the discovery well was completed in October 1953 by Southern Natural Gas Co. 1 Tamparello. Fig. 3B represents Franklin field as it appears today. Additional north-south faulting is evident from the recent control, which forms a typical deep-seated, graben-type salt dome. As is the case at Live Oak, the production at this stage occurs only on the upside of the fault; in this case that fault which dips to the west.

While north dip was first indicated by the Sparta Drilling Co. 2 Foster, later control proved this condition to exist because of the northwest-dipping fault. However, the really strong feature of the prospect was the presence of abnormal faulting — i.e., normal faults which dip other than coastward. This type faulting, together with the presence of multiple shows, is almost always associated with structural build-up in the Miocene trend of South Louisiana.

Turtle Bayou and Kent Bayou fields . . . The next area for study lies in northern Terrebonne Parish. The middle and lower Miocene in this area contains a higher precentage of shale. And the most prospective zones occur near the Bigenerina humblei zone rather than considerably below it, as in the case of the previous examples.

Humble began drilling in this area in 1936 with their 1 Continental Land & Fur (Fig. 4A). Stanolind became the next interested company some 5 years later and moved about 4 miles to the southeast to drill their 1 Continental Land & Fur.

These two points of control showed a rather flat condition existing between the two wells, which might have been interpreted as gentle nosing. In 1942, Humble drilled their second test, B-1 Continental Land & Fur, about 2,000 ft. southeast of their initial test. This well proved to be considerably lower than either of the original wells, and could best be explained by north dip from the Stanolind well and "down-to-the-coast" faulting between it and the Humble 1 Continental Land & Fur.

This fault could not be detected from the electric logs of either well. Humble's final attempt, B-2 Continental Land & Fur, added little to the picture other than to confirm north dip north of the fault.

For 6 years this area remained inactive. In December 1949, Shell Oil Co. completed their 1 Continental Land & Fur as the discovery well for Turtle Bayou field. In October 1950, Union Producing Co. opened production in

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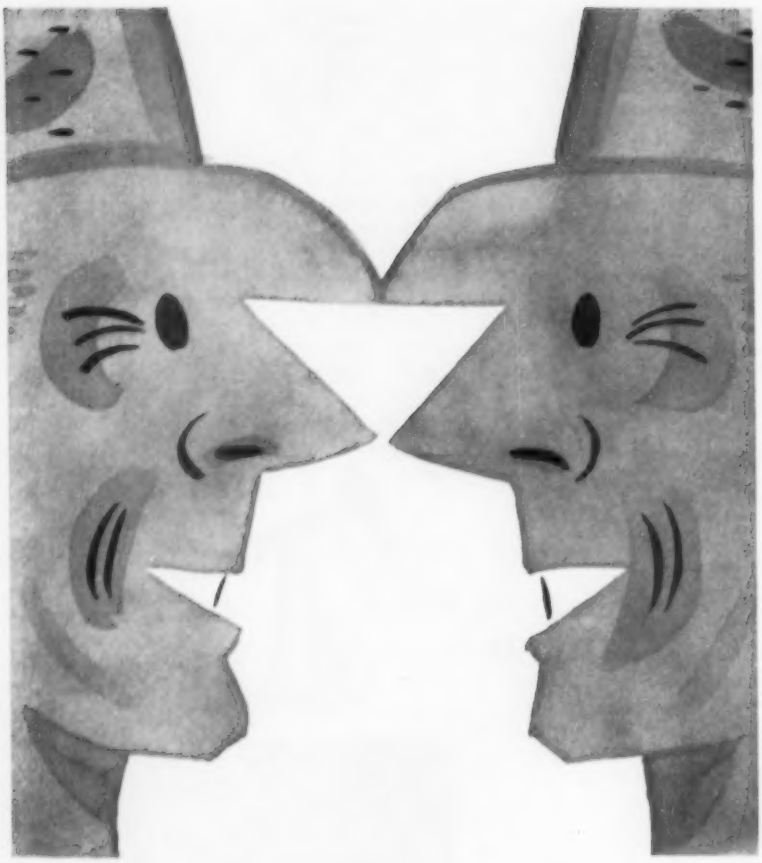

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the Kent Bayou area with their 1 Continental Land & Fur.

Later development has enlarged the original concept of this structure considerably (Fig. 4B). In addition, the fault which was pictured as running east-west between the two Humble wells now appears to run northwest-southeast. Although there is no available cutout in any of the wells drilled to date, there is strong evidence that this structure is bordered on the north by a large "down-to-the-coast" fault.

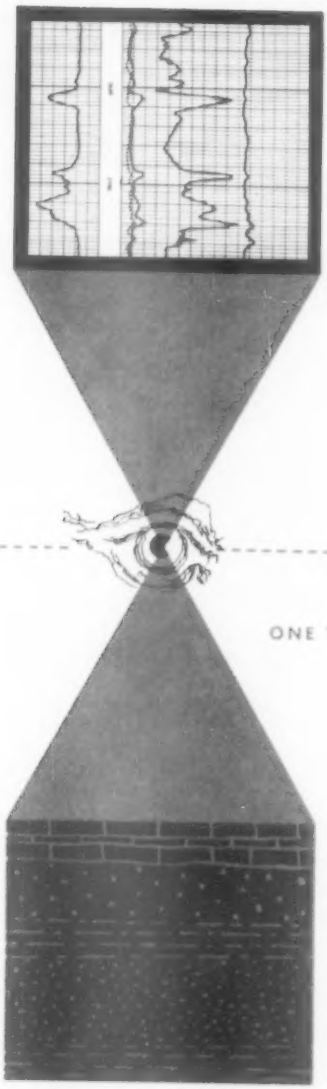
This example represents a simple case of the early operators drilling deep enough, but just off the crest of structure. In fact, the three Humble wells and the Stanolind well bracketed (in part, at least) a productive area of more than 4,000 acres.

These examples graphically illustrate that many of these prospects had "multiple optimum seismic locations." In some cases, none of these locations actually coincided with the crest of the structure. In others, one or more wells were structurally accurate, but failed because the bit did not reach the pay zone. While the reasons for the variations of seismic interpretations is beyond the scope of this paper, it must be admitted that they do exist, and that they exist frequently.

These illustrations are particularly interesting in that the prediscovery pictures showed the tops of the structures very near the actual crests as they exist today. This will undoubtedly be interpreted by many as a beautiful example of what can be done by the subsurface geologist when equipped with hindsight. On the contrary, similar interpretations of these areas were carried by several companies, and at least one company pictured all of these areas very much as they are shown in this paper.

Closure assures production . . . While these examples point out the effectiveness of subsurface geology in South Louisiana, they do not illustrate completely a condition which is rapidly becoming a fundamental premise among South Louisiana geologists. That is, where dip closure is present in the better Miocene trends of South Louisiana, production is virtually assured. If exploration is conducted in these trends with this assumption, then the seismograph becomes an even more important tool since its only task is to delineate these dip closures.

In addition, the acceptance of this basic idea makes the approach of the subsurface geologist relatively simple. His concern over the presence of reservoirs is eliminated, except for the problem as to whether existing wells have exhausted all deep possibilities. His primary problem is that of finding dip



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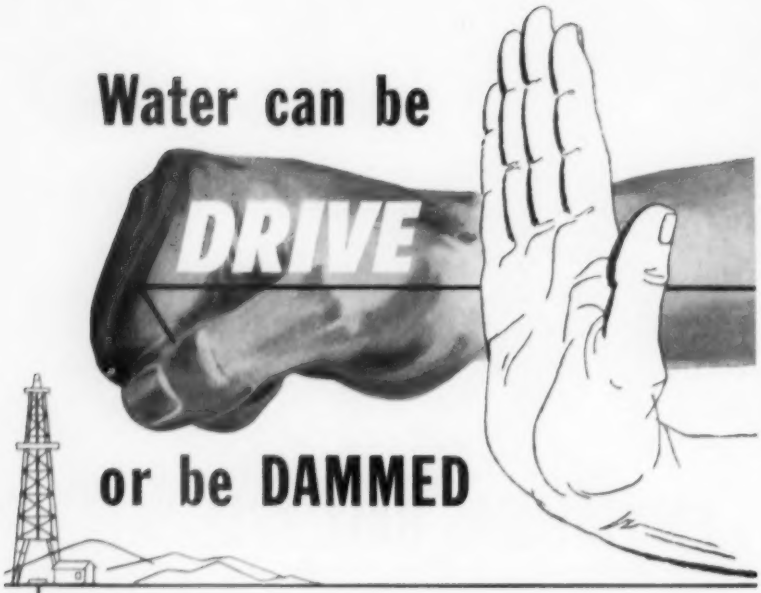

In water-flood projects, the injection water itself may be its own worst enemy—because it can (and often does) carry into the formation the very things most likely to plug the formation and thus slow, or halt, the water drive!

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Where the permeability of the injection formation is low, this extreme clarity is of great importance... witness, a field in California. Here, one project, now several years old, and using diatomite filtration, is injecting 4,000 bbl/day at 60 psi. Neighboring water-floods using sand filtration, can operate only at pressure of 400 psi, making the life of the flood questionable.

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closure. Since the regional dip in South Louisiana is coastward, even this problem is simplified. Consequently, the approach of the subsurface geologist is essentially that of finding north dip or an anomalous situation where the regional coastward dip is interrupted.

Assuming that the above conditions are essentially correct, the geologist who can without doubt show subsurface north dip or abnormal flatness between wells should have considerable persuasive powers over his management concerning any decisions made regarding such an area.

If his data are backed up by air-tight study, then it is the writer's opinion that any operator should ponder long and hard before making a negative decision, even though it may be substantiated by exhaustive seismic information. In short, the plea of the subsurface geologist might well be phrased, "Old prospects never die."

●

Editor's Note . . . The ideas expressed by Owen Brown follow very closely the lines of the article "Why Was My Well Dry?" This appeared in the November 14, 1955, issue of The Oil and Gas Journal, page 143.

"Why Was My Well Dry" outlined many of the pitfalls that can beset oil operators who do not consider all the factors or possibilities for oil production. The chart covers all phases from the preliminary geological or geophysical work through completion operations.

Both the Journal editors and the author of "Condemned Prospects" emphasize that many potential oil fields can be overlooked. Detailed knowledge of the area plus experience are invaluable assets in the finding of oil, but all possibilities must be considered before a prospect is condemned.

Reprints of the 17-page article "Why Was My Well Dry" are available from Reader Service Dept., The Oil and Gas Journal, P. O. Box 1260, Tulsa, Okla. Price: 50 cents.

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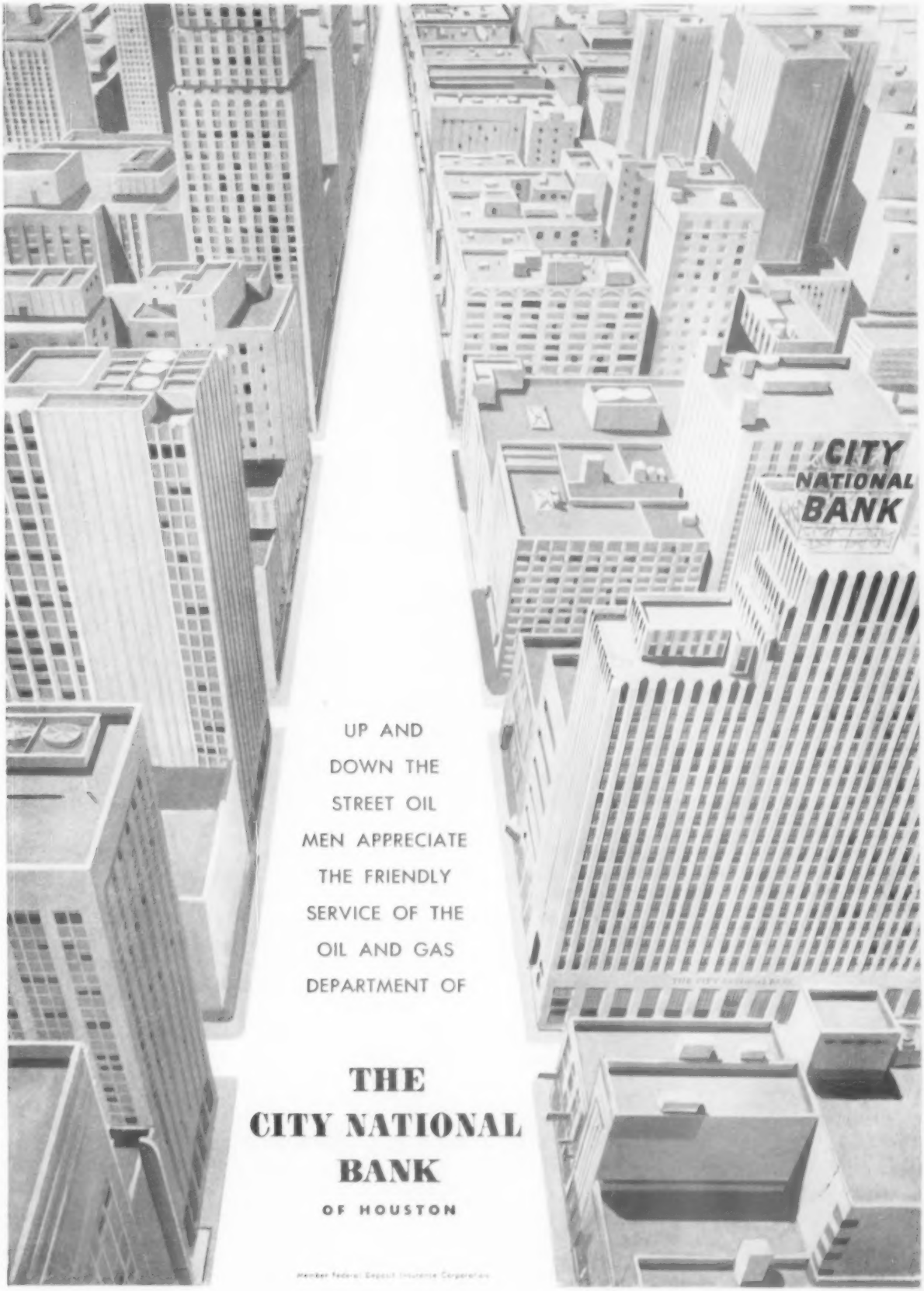

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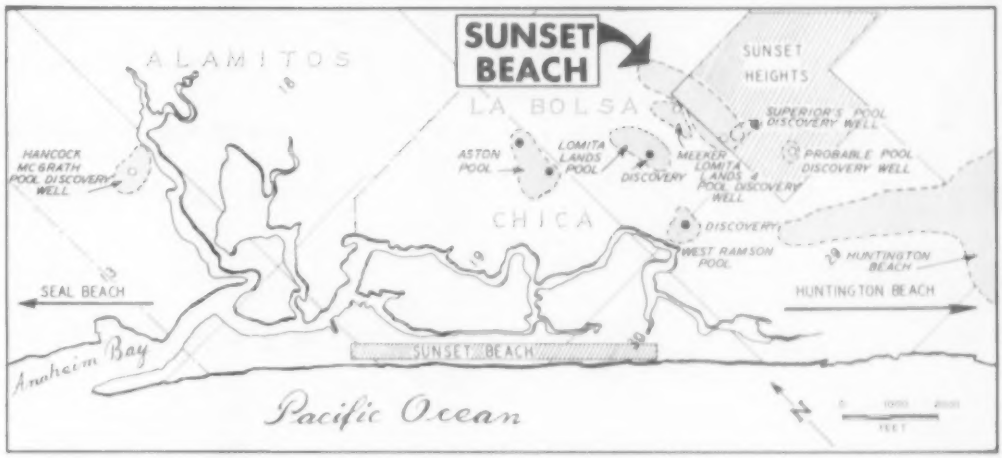

Another townlot drilling boom, reminiscent of Huntington Beach, may be in prospect for Sunset Heights.

Deep Discovery Keeps L. A. Basin in Limelight

William T. Smith

DISCOVERY of deeper, more prolific production in the Sunset Heights area of Sunset Beach field is expected to keep this year-old development the most active in the Los Angeles Basin. The first two completions in this new fault block flowed a total of over 4,000 bbl. daily on initial tests.

Albercalif Petroleum Co. 23 Albercalif-Crawford, SW SE 20-5s-11w, was deepened from 6,800 ft. to 7,858 ft. and completed flowing 2,700 bbl. on its first 24-hour test. Production is from the perforated interval 7,550-7,858 ft. through a 6-in. choke. One location away Superior Oil Co. brought in its 2-1 Halbrook-Isabel-Howard at 1,430 bbl. on an early test. This well, SW SE 20-5s-11w, is producing from 7,728-53 ft. This is equivalent to the main zone at Huntington Beach. The well site is about ¾ of a mile southeast of the field discovery well.

Extent of this new find is yet to be determined. The fact that it is in the Sunset Heights townlot area, however, foretells that development will probably reach a 1-acre well spacing.

Gap closed . . . The completion of those two prolific producers marks another development in drilling activity in this area between Huntington Beach and Seal Beach which has uncovered substantial oil production in a previously 4-mile "dry" area. Discovery of this field closes the gap between the two Los Angeles Basin fields.

Activity this year has been exceeded only by the Jones sand flurry at Huntington Beach. Production in the area in January 1955, amounted to only 915 bbl. daily from 5 wells. In October, it had built up to almost 9,000 bbl. daily from 57 wells.

Dozen rigs . . . The rapid development of this highly faulted area has kept nearly a dozen drilling rigs busy all year. At the present time 10 wells are being drilled in the field with sites for several more being readied.

Development has been characterized by operators trying to extend the production of known pools and, instead, quite often hitting new fault block pools. This is pointed up by the fact

Pictured are three drilling rigs in operation in the Sunset Heights area of Sunset Beach field, Orange County, California. This is the scene of recent completion of two rich producers.

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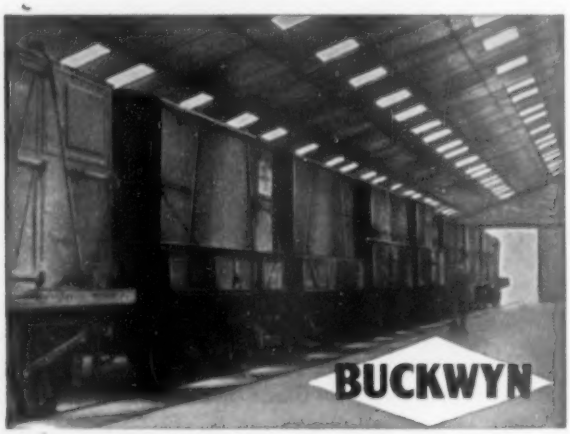

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that from the original field discovery, the area has grown to at least 7 confirmed pools. The areas of production range over about 2 miles with the majority of crude coming from wells in the southern part of the field. Gravities of crude produced thus far are between 29.1° and 31.7°. While the field discovery well enjoyed fairly flush production, the Albercalif and Superior wells are the most prolific.

History . . . The Sunset Beach area, located between the huge Huntington Beach field on the south and Seal Beach field on the north, had lain dormant for years until last year. Except for sporadic wildcatting, mostly in the 5,000 ft. category, this marshland had seen little drilling activity.

Signal Oil & Gas Co. had successfully developed its Bolsa Chica lease to the south along the Inglewood fault, main source of production in the Huntington Beach field, but efforts by other operators to extend the limits northwestward had failed. Several wildcats were drilled virtually in the middle of the new field in the 30's and 40's but were all too shallow, and missed the pools.

Aside from occasional circulation losses due to the heavy faulting, drilling operations in the field are routine. Thus far, all development has been northeast of the Inglewood fault about in line with the south edge of the Seal Beach fault.

The High School branch of the Inglewood fault, which so far constitutes the western limit of Sunset Beach field, is a main fault break along the Inglewood fault zone as is the Seal Beach fault. The Inglewood fault zone extends approximately 30 miles from the 20th Century-Fox movie lot in Beverly Hills to West Newport Beach.

Field discovery . . . The discovery well, drilled to Aston, was an effort to find production associated with either the High School fault production extending up from the southeast or the Seal Beach fault extending down from the northwest. The wildcat, 2 Lomita, hit production in the lower part of the lower Ashton zone, one of the zones producing at Huntington Beach. Judging from subsequent production, the discovery well apparently is not favorably located in the new pool, or else the pool is small. It was completed in June 1954.

This wildcat, located SE NE 19-5s-11w, was drilled to 8,707 ft. and then plugged back to 5,300 ft., whipstocked, and redrilled to its present depth of 7,185 ft. The producing formation of this well, which was spudded in as 1 Lomita and then renamed 2 Lomita when it was whipstocked, is upper

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"Buck" Dotson standing amid eight flanged end MUDWONDERS on the mud manifold of Big Chief Rig #32.

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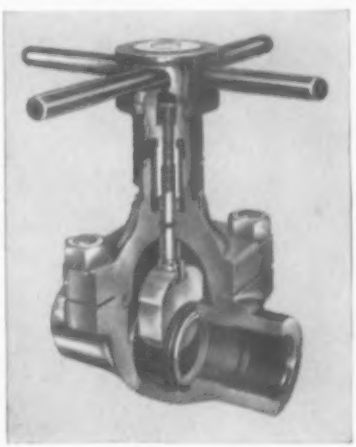

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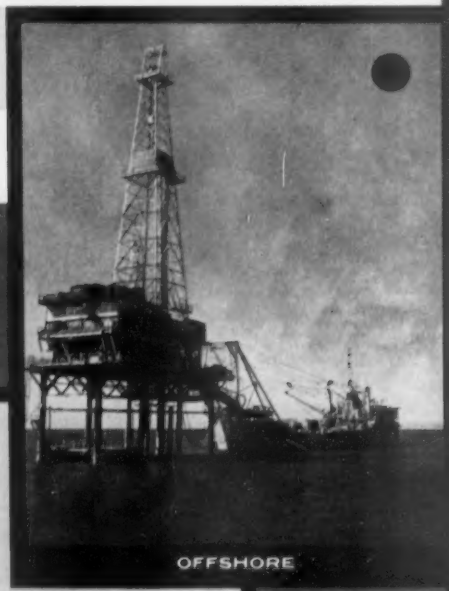

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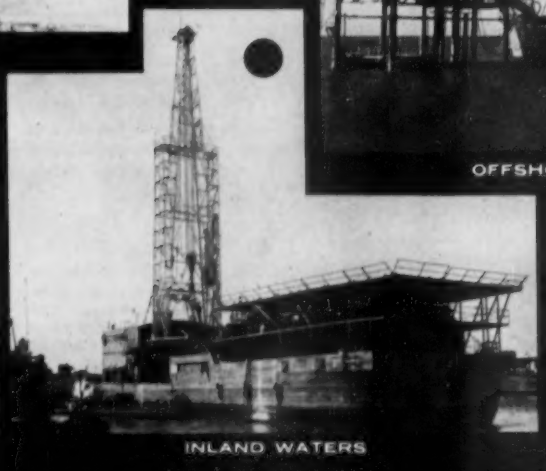

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Miocene in age. Two other wells have since been put on production in this pool.

Later in the year Atlantic drilled a wildcat about ¾ of a mile south of the discovery. Atlantic's decision was based on studies of two old wildcats drilled in the same area which suggested a fault which might control an extension of the Signal production to the south. Later developments confirmed the accuracy of that opinion. Atlantic 1 Ramser was spudded in NW NW 29-5s-11w.

This wildcat tapped a new pool between 6,100 ft. and 6,400 ft. On the basis of produtcion and pressures encountered it was labeled a new pool discovery—the West Ramser pool. Production is from the upper part of the lower Ashton zone. Five wells are now producing from this pool discovered in November 1954.

Another pool hit . . . The next operator to get into the Sunset Beach field action was W. L. Meeker. As in previous tests, Meeker was aiming at proven producing zones with his 1 Lomita Lands. Meeker's wildcat, SE NW 20-5s-11w, was scheduled to try for either Ashton's field discovery pool or Atlantic's West Ramser pool. This wildcat was located a little over 2,000 ft. southeast of Aston's field discovery and 1,500 ft. northeast of Atlantic's pool discovery.

But in keeping with the trend in this highly faulted field, it missed both and, instead, discovered a new pool, the Lomita Lands pool. The well did hit some oil shows on the edge of the Ashton zone enroute to total depth but they were not commercial. Production was found in the equivalent of the offshore main zone of the Huntington Beach field. The stratigraphically deeper pool is probably in a separate fault block than the Aston and Atlantic pools.

Production at 1 Lomita Lands is from a perforated interval of 7,899-8,000 ft. The formation is upper Miocene. Two other wells have been completed in this pool.

Albercalif then teamed up with J. B. Crawford on a wildcat on a line southeast of the Aston and Meeker discoveries. Again the heavy faulting features of the field were confirmed. The wildcat, 11 J. B. Crawford et al, found a new pool in the lower part of the lower Ashton zone, approximately equivalent to Ashton's field discovery pool ¾ of a mile northwest.

The well in SW SE 20-5s-11w bottomed at 6,600 ft. with production coming from the perforated interval 6,461-6,600 ft. It was completed in January of this year. The discovery touched off a town lot site drilling play

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which has seen 30 wells completed in the new pool.

This pool is geologically well defined. It is bounded on the west by a fault trending about 15° west of north. It is in a fault block which dips to the east and northeast. A subsidiary fault block in which 3 wells have been completed parallels this on the west. Meeker 4 Lomita Lands discovered this parallel fault block pool when it was whipstocked and drilled over the fault block from which the Albercalif-Crawford wells are producing.

While the Ashton, Meeker, Crawford, Atlantic and Superior developments are all fairly close together, the other important pool in the area is located almost 16 miles north of the discovery area.

This consists of Hancock Oil Co. Alamitos wells in McGrath pool on the south edge of Seal Beach field. Hancock was drilling ahead at 8,103 ft. on 10 Alamitos after completing 9 wells producing more than 1,000 bbl. of crude daily. These wells are located SE NE 13-5s-12w.

The area between Hancock's wells and Ashton's discovery well is virtually unexplored. Three wildcats were drilled between these two points in the late 20's and early 30's but all were unsuccessful shallow tests.

As to the future it is believed that the possibilities for further pool discoveries are great. Additional fault block discoveries are foreseen east of Superior's rich well as the field is extended in that direction.

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CALIFORNIA

California Gas Field Highlights

Drilling activity in California's gas fields was highlighted by developments in Glenn and Colusa counties.

Gene Reid Drilling Co. was running casing in 1 Capital Co. in the Willows area while Humble Oil & Refining Co. staked a wildcat site 2 miles southeast of Afton field.

Reid's test, located 4 miles southwest of Beehive Bend field, was at 5,993 ft. and slated to go to 7,000 ft. Humble's proposed wildcat is located SE SE 11-18n-1w.

In other gas field developments, Brazos Oil & Gas Co. announced 1 Dow-Humble-Handlery at 5,662 ft. when it flowed salt water on a test of the perforated interval 4,808-16 ft. This wildcat was 4 miles northeast of the town of Maxwell in Colusa County.

Honolulu Oil Corp. was cementing casing in its 1 Honolulu-Humble-Carter, a wildcat 1 mile southeast of its 3,700-ft. South Princeton field discovery in Colusa County. This test, SW SW 7-17n-1w, was at 3,400 ft.

Third Completion In Flush Sunset Beach Pool

A third prolific completion in a new fault block pool at Sunset Beach pointed up the growing importance of the recent discovery.

Harry J. Hill brought in 1 Golden West for 1,200 bbl. daily at the perforated interval 7,748-7,967 ft. This producer is several hundred feet south of two recent flush completions in what appears to be the same zone. This well is NW NE 29-5s-11w.

About 400 ft. northeast of 1 Golden West, Atlantic Oil Co. was cementing casing in its 7,870 ft. deep 2 Freeman. This test is reported to have hit 160 ft. of oil sand at a depth 100 ft. higher than the Hill producer and 100 ft. lower than Superior Oil Co. 2-1 Halbrook to the north.

Superior 2-1 Halbrook set the pace for this deeper production in Sunset Beach field when it was completed in October flowing 1,430 bbl. at the interval 7,728-53 ft. Shortly after that, Albercalif. Petroleum Co. deepened 23

Albercalif-Crawford from 6,800 ft. to 7,858 ft. and completed it for a reported 2,700 bbl. daily. This well is one location west of Superior's 1 Halbrook in 20-5s-11w.

San Mateo Field Discovery Offset Slated

Union Oil Co. announced a northwest offset to its recently completed new field discovery in the Boulder Creek area of San Mateo County. The new test, 2 Richfield-Costa, is located NE NW 14-8s-3w. The discovery well, 1 Richfield-Costa, was flowing 85 bbl. daily of 42.8°-gravity crude at last reports.

Set Casing In Shell Posuncula Deep Test

Casing was being cemented to 12,425 ft. in Shell Oil Co.'s western extension test in the Strand-Posuncula area of Kern County. This latest test, located ¼ mile west of the pool discovery well, will be completed in the deeper Vedder sand. A recent south extension failed in the Vedder but was completed in the 9,000 ft. Stevens.

Standard Abandons Deep Test

Standard Oil Co. of California has abandoned 341 Van Wy, a 12,337 ft. wildcat 2 miles east of southern South Belridge production in Kern County. The Buttonwillow basin wildcat was plugged back from total depth to 1,625 ft., whipstocked and redrilled to 1,890 ft. before Standard gave up on it. It was located NE NE 8-29s-22e.

Dominguez Offset Staked

J. K. Wadley has staked a west offset to the recently completed 1 Condren in Dominguez field in Los Angeles County. This new test, located on the northwest edge of the pool, is scheduled to drill through the entire Seventh Callendar zone, source of production in 1 Condren. The third test by Wadley is tentatively scheduled to check the Eighth Callengar, however, no drill site for this test had been set.

Wadley's 1 Condren was completed in early November flowing 840 bbl. daily of 36°-gravity crude through a ¾ in. choke.

WASHINGTON

Another Washington Wildcat Abandoned

Seattle Toldedo Oil Co. has abandoned its 2 A. M. Hoskins wildcat in the Cowlitz River basin of Lewis Coun-

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ty, Washington. The 4,712-ft. test was 5 miles southeast of the town of Ethel.

Efforts to add Washington to the nation's list of oil-producing states continues with one other wildcat drilling ahead and a site for another test being readied. Richfield Oil Corp. was coring and drilling ahead at 7,977 ft. on 1 Weyerhauser in Grays Bay area of Wahkiakum County, while Colorado & Wyoming Drilling Co. was getting ready to spud in on a site in the Coal Creek anticline region of Lewis County.

HUGOTON EMBAYMENT

TEXAS PANHANDLE

Completion Due at Morrow Gas Hit in Ochiltree

Casing is set for completion try at Superior Oil Co.'s 1 Oringderff, Morrow gas discovery 5 miles southwest of Perryton in Ochiltree County.

The well flowed gas at the rate of 11,500 M.c.f. per day on drill-stem test of the Morrow sand at 7,922-51 ft. The test also recovered 1 bbl. of distillate. This wildcat is 8 miles northwest of Farnsworth field in the north-central part of Ochiltree County in Section 21, Block 12, H&GN Survey.

Extension to Laketon Field Assured in Gray County

Phillips Petroleum Co. has extended Laketon-Ellenburger field in Gray County ½ mile to the northwest.

The company's 1 Strickler "A," Section 111, Block M-2, BS&F Survey, flowed 39 bbl. of oil during the first hour of a test at 11,258-83 ft. with 1,360 M.c.f. of gas per day. Gas-oil ratio was 1,453:1. The well made 10 bbl. the second hour.

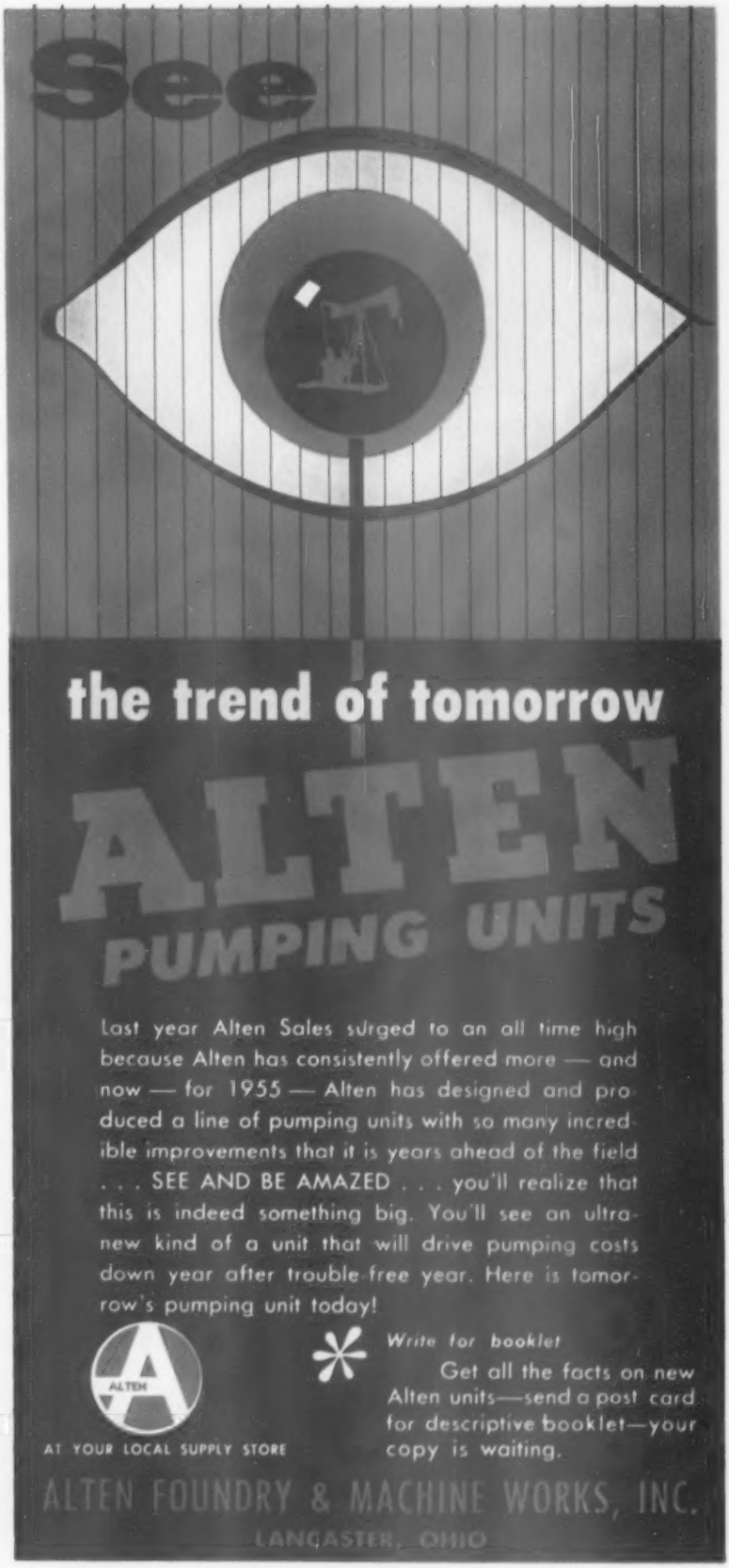
Union discovery . . . Union Oil Co. of California 1 Bucqhaylts, another Morrow discovery in Ochiltree County, is testing. The oil prospect, ¼ mile northeast of Farnsworth gas field, flowed 10 bbl. of oil per hour for 10 hours. This test is in Setcion 32, Block 32, I.T.M. Survey.

SOUTHWEST KANSAS

Morrow Gas Shows to Be Tested at Seward Wildcat

Morrow gas shows at the 1 Massoni in C SW SE 5-33s-31w, 2 miles west and 1 north of Northwest Kismet field, will be tested by Cabot Carbon Corp.

Gas flowed from the Morrow sand on drill-stem test at 5,518-97 ft. The well is ½ mile west of Kismet.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Kansas City Discovery Indicated in Comanche

Comanche County is in line for a new Kansas City gas discovery. Pure Oil Co. 1 Hazel Beals, 12 miles south of Coldwater, flowed at the rate of 5,594 M.c.f. of gas per day on a drill-stem test at 4,348-4,420 ft. The discovery is 18 miles south of Robbins field.

More Gas Reported at Morton County Prospect

Panhandle Eastern Pipeline Co. is perforating for further tests at its 1 Murphy, C SW 15-32s-41w, Morton County Morrow gas prospect on the west edge of Hugoton field.

The well flowed at the rate of 2,572 M.c.f. per day from perforations at 5,204-10 and 5,197-5,204 ft. The well is 2 miles west of Richfield field.

OKLAHOMA PANHANDLE

Production Tests Under Way at Beaver Discovery

Warren Petroleum Corp. is making production tests at its 1 Bowles in southwestern Beaver County. The wildcat, located in SE SE NW 22-1n-20eCM, recovered 10-12 bbl. of oil per hour after treatment from perforations in the Morrow at 7,253-66 and 7,272-78 ft.

The discovery is located 3 miles east of Camrick field.

GREAT LAKES

MICHIGAN

Second successful Traverse oil well in the new Huber Traverse oil pool, Denver Township, Newaygo County, was being completed at the east 20-acre to discovery well in the field.

This first well to reach objective pay zone in this pool since the discovery was completed was Carter Oil Co. 1 Allers, SW SW SW 4-14n-14w. Although well was checked in structurally lower than the discovery on top of Traverse lime objective by 18 ft., well showed gas to surface in 2 minutes and was flowing oil in 3 minutes on a drill-stem test run at 2,098-2,121 ft. Top of Traverse lime was logged at 2,104 ft. Of the 10 to 13 ft. of effective pay cored in the 1 Allers, best porosity showed at 2,107-12 ft. Other fair to good porosity was cored at 2,104-07 ft., 2,113-15 ft. and at 2,116-18 ft. Bottom-hole pressure showed for 815 pounds.

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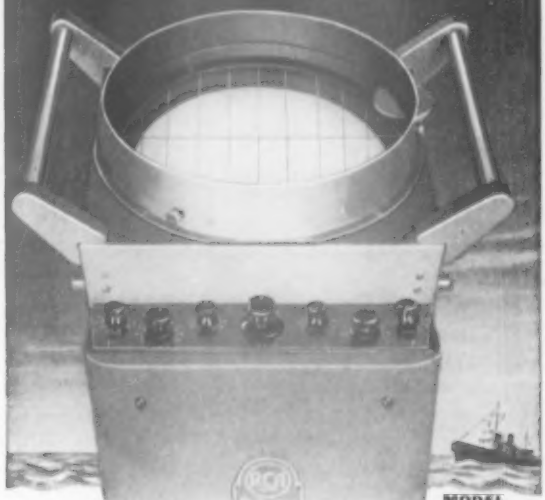

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about 1 hour on drill-stem test, tool was closed, pulled and additional section, between 2,121 and 2,158 ft., so-called Stony Lake zone, was cored. This section showed hard, dense limestone and dolomite. No test was run. Hole was reamed in preparation for setting 5-in. casing through pay section. Pay will be perforated on final completion procedure.

The Carter Oil Co. will move rotary rig from the 1 Allers to another location on the same lease, the diagonal northeast 20-acre offset in the NE SW SW 4-14n-14w.

Two other active cable tool operations are in progress in the pool, one at the south 20-acre offset and the other at the northwest 20-acre offset to the discovery. Both are being drilled by Discoverer Klondike Petroleum Co., Inc. One of these should reach pay objective in next 7 to 10 days.

Operators have requested that a diagonal 20-acre well spacing pattern and a possible per-well proration allowable be reviewed in public hearing before Supervisor of Wells Gerald E. Eddy and the State Advisory Board in Lansing on November 21.

EASTERN INTERIOR

ILLINOIS

Five New Oil Pools, One Gas in Illinois in October

Five oil pools and one gas pool were discovered in Illinois in October, according to the State Geological Survey Division of the Department of Registration and Education. The new pools are Redmon North (gas) in Edgar County, Russellville West in Lawrence County, Iuka West in Marion County, Wakefield South in Richland County, Kincaid South in Christian County, and Murdock in Douglas County. The discovery well of Murdock pool is the first commercial oil well drilled in Douglas County.

Drilling and production continued at a high rate during October. A total of 378 wells were completed during the month. It is interesting to note that 10 years ago, in 1945, drilling in Illinois dropped to the lowest point since development in the Illinois basin got well under way in 1938. In October of 1945 only 130 wells were completed, or approximately one-third as many as in October 1955. Most of the increase in activity has come during the last 2 years, and the trend is still upward.

Production showed a slight drop in October, daily average production being 232,000 bbl., or an estimated 7,180,000

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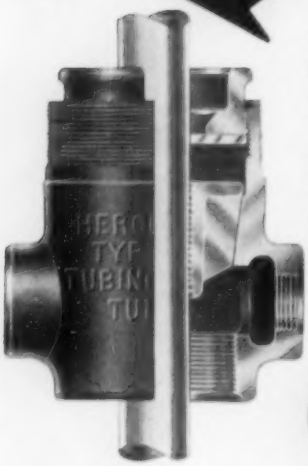

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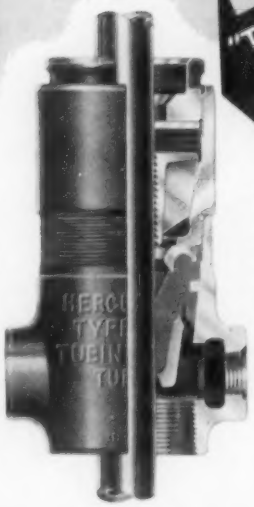

The dual-purpose "Type J-5-S" Stripper Tubing Head is basically a "Type J-5" Tubing Head with a bowl (top section) screwed into the packing nut thread. The hinged slips, packing and packing nut are installed in the bowl (top section) with the tubing stripper in the body (lower section), thus permitting tubing to be run-in, or removed under pressure. Test pressure is same as the "Type J-5" Tubing Head.

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bbl. for the month. This is over a million barrels more than during October of 1954, and over a million and a half barrels more than in October 10 years ago.

Six extensions were discovered during October, one to each of the following pools: Cooks Mills East in Coles County, Herald Consolidated in Hamilton County, Eldorado Consolidated and Mitchellsville in Saline County, Ellery East in Edwards County, and Dale Consolidated in Hamilton County. New pays for the month were the McClosky limestone in the Louden pool, and Degonia sandstone in the Mitchellsville pool, and the Renault limestone in the Eldorado West pool.

One of the most interesting oil field developments at present is in Bond County. In September a Devonian sandstone well was completed on the north edge of Sorento pool with an initial production of 365 bbl. per day. During October four more Devonian sandstone wells were completed with initial production of 324, 720, 724, and 960 bbl. per day. Seven more wells are drilling and permits have been issued for half a dozen more.

APPALACHIAN

EASTERN KENTUCKY

A good shallow gas well has been completed by Kentucky West Virginia Gas Co. at their 1049 Jane Hopkins. Located on Arnett Branch in the Floyd County sector of Big Sandy gas field the test yielded gas naturally at the rate of 1,309,000 cu. ft. daily. Producing horizon is the Mississippian Maxon sand topped at 916 ft. and drilled to 951 ft. total depth. An 180 pound rock pressure was recorded in 12 hours.

OHIO

Two completions along the north edge of Flint Ridge pool in Hopewell Township, Licking County, widened its known productive areas. Natol Corp. 1 Clayton Moore, Lot 10, found the Clinton at 3,063-99 ft. and gaged 200 bbl. in a 24-hour test after fracturing. The same operators 2 G. Dilley, Lot 9, with sand at 3,136-65 ft. gaged 40 bbl. and 725,000 cu. ft. gas daily.

● Oxford Oil moved over a dry hole to extend Cottage Hill pool in Hopewell Township, Muskingon County. Clinton at 3,189-3,249 ft. gaged 55 bbl. in 24 hours after treatment.

● In the northwest part of New Castle pool, Piedmont Oil Co. completed a combination well on 1 C. B. Bell, 2nd Qr. Clinton was logged at 2,944-75 ft. and gaged 500,000 cu. ft. with 30 bbl. oil after fracturing.

PENNSYLVANIA

Banks Township, Indiana County, Southwest Pennsylvania, Columbian Carbon Co. 1831 Farmers & Miners Trust Co. is at 484 ft.

WEST VIRGINIA

Licking district, Tucker County, West Virginia, Hope Natural Gas Co. 9966 T. A. Loughry, wildcat, is drilling at 3,631 ft.

● Clover district. This company's 9967 Walter Hovatter is rigging up.

● In St. George district, Columbian Carbon Co. 1215 U.S.A. is at 5,120 ft., and 1219 U.S.A. at 3,222 ft.

● Greenbank district. Pocahontas County, Columbian Carbon Co. 1220 U.S.A. shut down at 3,182 ft. for repairs, and 1223 U.S.A. is drilling at 1,345 ft.

MID-CONTINENT

OKLAHOMA

Completion Made at North Madill-Ordovician Field

A dual completion has been reported in North Madill field, Marshall County. The well is Sinclair Oil & Gas Co. 3 Nunley, SE SW NW 15-5s-5e. Initial flow of 28 bbl. per hour was reported

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While the Bank is prepared to provide all available information on the oil industry, it does not make recommendations regarding the purchase of individual oil stocks.

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from perforations in the McLish sand at 6,704-19 ft. Completion test was 540 bbl. per day on ½-in. choke. The Third Bromide sand made 576 bbl. per day on ½-in. choke from 6,256-76 ft.

Misener-Unconformity Sand Discovery Near Choctaw

Oklahoma County has a new oil pool at Reda Pump I Osborn, NW NW NE 2-11n-1w. The well, south of Choctaw, flowed 50 bbl. per hour on ½-in. choke from perforations at 5,940-46 ft. Other tests flowed at the rates of 42 and 30 bbl. per hour on ½-in. choke.

Well No. 43 Finished At West Short Junction

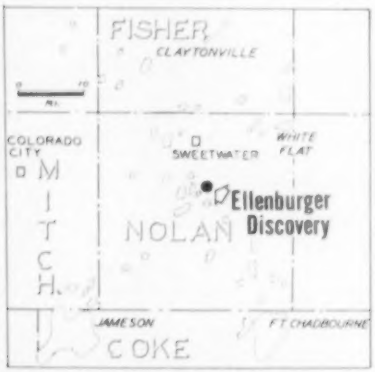
Continental Oil Co. finaled the 43rd well in West Short Junction field, Cleveland County. The I Shultz, C NW NW 26-10n-4w, made 142 bbl. of oil per day on 10/64-in. choke from perforations in the Bois d'Arc.

NORTH TEXAS

Central Nolan County Well Is Ellenburger Discovery

C. L. Norsworthy, Jr., 1 Mrs. William Wight Heirs, in 94-22-T&P Survey, 10 miles southeast of Roscoe, opened an Ellenburger pool, with a daily potential of 150 bbl.

Operators drilled into the pay section at 6,820 ft., on elevation of 2,505 ft. After perforating at 6,838-74 ft. and acidizing with 500 gal., the well made the 150-bbl potential through 16/64-in. choke. Gas-oil ratio was 850:1, with tubing pressure of 175 psi.



Central Nolan County has a new Ellenburger pool. Location is 10 miles southeast of Roscoe.

KANSAS

Free Oil Found At Sheridan Wildcat

Imperial Oil Co. of Kansas has reported free oil at its 1 Schoen, indicated Lansing discovery in SE SE SE

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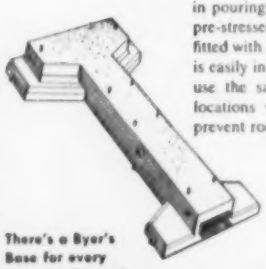

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12-6s-27w, 1 mile southeast of Adell pool, and 5 miles northwest of the city of Lucerne.

Recovery on a test at 3,609-23 ft. was 30 ft. of gas and 40 ft. slightly oil-cut mud. Another test at 3,636-55 ft. made 75 ft. muddy oil; another at 3,732-50 ft. recovered 1,205 ft. of gas and 540 ft. of free oil.

Testing Due At Pawnee County Wildcat

Mississippian oil shows will be tested at a promising Pawnee County discovery. Rine Drilling Co. 1 Draper, NE NW NW 22-20s-20w, 2 miles southwest of Shiley pool in the northwestern part of the county, recovered 240 ft. of oil-cut mud and 240 ft. heavily oil-cut mud on test of the Mississippian at 4,268-4,301 ft.

WESTERN CANADA

BRITISH COLUMBIA

Richfield Begins Wildcat Program in British Columbia

Richfield Oil Corp. has entered B.C. with a drilling program scheduled 100 miles northeast of Prince George.

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Crews are working in the Stony Lake area at Monkman Pass under agreement with Caliph Petroleums, Central Leduc Oils, Ltd., and Del Rio Producers, Ltd. The company will drill 11,000 ft. at an estimated cost of $750,000. Seismic work will be carried out between now and February when the drilling program is to begin. The area to be tested is south of the Dawson Creek gas-producing area.

ROCKY MOUNTAIN

MONTANA

Clark Fork Area Dakota Discovery Tested

British-American Oil Producing Co. recovered oil at the rate of 20 bbl. per hour on test of Dakota at a wildcat 2 miles northwest of Clark Fork in Carbon County. The well also flowed gas at the rate of 5,000 M.c.f. per day.

The wildcat is 1 State, C NE SE 16-9s-22e. Test was at 8,900-49 ft., with tool open 45 minutes. Gas flowed after 6 minutes, oil after 16 minutes. Pipe recovered was 982 ft. of oil and 180 ft. of mud. British-American reported a flowing pressure of 2,700 psi. at the end of the test, and shut in pressure of 3,580 psi.

Top of Dakota was found at 8,900 ft., and at last reported depth of 8,959 ft. the operator indicated that 56 ft. of apparently productive sand was believed cut. British-American is coring below 8,959 ft., after running logs to that depth.

Production at Clark Fork proper was found in 1949, when General Petroleum Corp. completed a 200-bbl. per day producer in Frontier. This well was later abandoned. In 1949, also, British-American found Dakota production in the field. J. Ray McDermott & Co. had a basal Frontier discovery in 1954. These wells are within the older producing area, which is west and slightly north of Northwest Elk basin. There has been no previous drilling in the immediate vicinity of the present discovery, which is on acreage farmed out to British-American by The Texas Co.

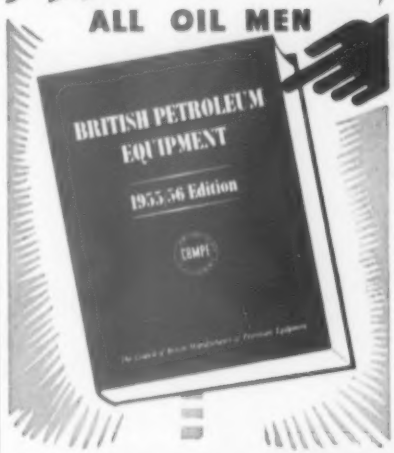
NORTH DAKOTA

Oil Recovered at Renville County Confirmation

Sohio Petroleum Co. recovered oil on test of Charles at 1-B Ritter, NW NW 24-163n-86w, for an apparently successful confirmation of its recent Renville County discovery. Test at 4,479-98 ft. with tool open 3 hours recovered 450 ft. of free oil, 90 ft. of

Attention!

ALL OIL MEN



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mud-cut oil, and 370 ft. of salt water. The operator is coring below 4,500 ft.

The discovery well in this field was 1 Ritter, SE NE 23-163n-86w. It produced 374 bbl. of oil per day on pump. The operator has also made location for two additional wells in the same township. The new pool, which has been designated Bluell field, is regarded as one of the most important of the year in the Rockies because of its position east of the Nesson anticline and its potential impact on Williston basin drilling in North Dakota.

Successful Wildcats

ARKANSAS

Miller County: McAlester Fuel Co. A-1 Stella Hervey, 1-15s-26w. 2 miles SE of Hervey and 6 miles west-northwest of West Midway field. IPP 68 BOPD, Hill sand-Rodessa 3,619-23 ft., 20.5°. TD 6,648 ft. (Discovery well of Hervey field.)

SOUTH LOUISIANA

Iberville Parish: J. R. Meeker 1 Wilbert, 36-10s-11e. IP 2,000 M.c.f. daily and 50 BCPD, ⅜-in., perfoated 11,058-64 ft. TD 11,765 ft. (New gas-condensate pay in Bayou Plaquemine field).

CALIFORNIA

Santa Barbara County: Union Oil Co. 37 Union Sugar, 11-10n-36w. IPP 117 BOPD, 7 M.c.f., perfs. 3,630-3,220 ft., TD 3,630 ft. (Extension ½ mile south of Guadalupe field.)

COLORADO

Logan County: British-American 1 Griffith, C SE SE 9-11n-54w. IPP 162 BOPD, "J" sand discovery, new field. TD 5,527 ft. "J" sand.

Washington County: New Drilling Co. 1 Schrieber, C SW SW 25-3s-56w. IPP 152 BOPD, "J" sand discovery, new field. TD 5,154 ft. "J" sand.

ILLINOIS

Christian County: J. F. Hinkle 1 Hinkle, NW NW NW 15-13n-3w. IPF 416 BOPD, Devonian 1,820-26 ft. TD 1,826 ft. (Oil discovery).

Douglas County: Gallatin Drilling Co. 1 Wagner, SW SW SW 26-16n-10e. IPP 8 BOPD, Pennsylvanian 378-395 ft. TD 395 ft. (Opens Murdock pool).

KANSAS

Harper County: Aurora Gasoline Co. 1 Miller, SE SE NE 11-33s-8w. IPF 427 BOPD, Mississippian 4,895-4,900 ft., ½-in., 45°. TD 5,147 ft. (Oil discovery).

Kingman County: Pickerell Drilling Co. 1 Wells-Towner, SW SW NE 17-30s-7w. IPP 46 BOPD, Mississippian 4,147-53 ft., 32°. TD 4,250 ft. (Opens Rago pool).

Aurora 1 Hufford, NW NW NE 23-30s-7w. IPF 178 BOPD, Mississippian 4,143-59 ft., 37.2°, ½-in. TD 4,725 ft. (Oil discovery).

Kiowa County: Falcon-Seaboard-Gulf Oil Corp. 1 Herring, NW NW NE 15-28s-16w. IP 4,800 M.c.f. of gas per day, Marmaton 4,680-88 ft. TD 4,819 ft. (Gas discovery).

NORTHWEST NEW MEXICO

San Juan County: El Paso Natural Gas Co. 1 Kelly-State, NE SW SW 16-25n-12w. IPF 180 BOPD, 100 M.c.f. of gas per day, Gallup discovery, new field. TD 5,150 ft. Sanastee.

Sandoval County: Reynolds Mining Co. 1 Jicarilla, NW SE SE 29-23n-3w. IPP 13 BOPD, Tocito discovery, new field. TD 8,432 ft. Entrada.

NEBRASKA

Cheyenne County, Rudolph: C. G. Novotny and New Drilling Co. 1 Randolph, C SE SE 9-13n-51w. IPP 190 BOPD, "D" sand discovery, new field. TD 4,975 ft. "J" sand.

OKLAHOMA

Murray County: Frankfort Oil Co. 10 Baldwin, NE NE SE 5-1s-1e. IPF 474 BOPD, Arbuckle 6,537-6,669 ft., ¾-in., 37.5°. TD 6,669 ft. (Oil discovery).

Stephens County: W. B. Cleary, Inc., 1 Ely, NW NW SE 9-1n-8w. IPF 344 BDPD, 5,269-89 ft. Lower Rowe sand, 2-in. tubing, 65°. TD 5,420 ft. (Distillate discovery).

TEXAS GULF COAST

Austin County: Shell Oil Co. 1 Cole, Lot 2, Block 24, San Felipe De Austin Town Tract. IP 4,500 M.c.f. daily, open-flow potential, GLR 32,100 cu. ft. per barrel, 63.9°, perforations 9,869-94 ft. and 10,-176-96 ft. (Wilcox). TD 11,801 ft. (New pay in Sealy field).

Calhoun County: Houston Natural Gas Production Co. et al 1 Ed See est., Valentine Garcia Sur., A-17. IP 23,500 M.c.f. daily, open-flow potential, 9½ BC per M.M.c.f., 56°, perforations 6,881-90 ft. TD 9,550 ft. (New field.)

Cameron County: Texas Gulf Producing Co. 1 Vista Del Mar, Share 6, Potero de San Martin Jose Ygnacio de Trevino Grant, A-6. IP 10,000 M.c.f. daily, open-flow potential, dry gas, perforations

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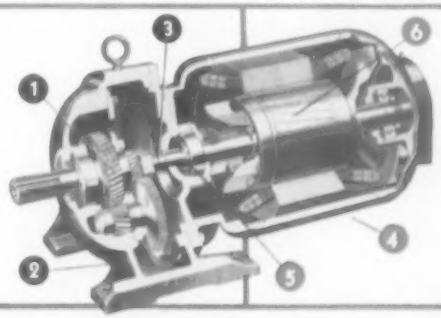

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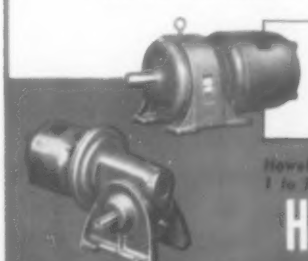

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7,414-26 ft. TD 10,303 ft. (New field—second discovery in county.)

Hardin County: James W. Porter 1 Choate fee. C. Choate Sur., A-153. IPP 230.29 BOPD, 22.7°, perforations 2,901-26 ft. TD 3,447 ft. (New pay in Batson field.)

Jefferson County: Sun Oil Co. 1-B Broussard & Hebert, Lavon Hamshire Sur. 212, A-150. IP 32,000 M.c.f. daily, open-flow potential, perforations 9,007-17 ft. TD 9,150 ft. (New pay in, and extends La Belle field.)

Liberty County: Jack W. Frazier 1 W. J. Barrett est., Rebecca Coleman Sur. IP 217.21 BOPD, ⅛-in., 36.4°, perforations 8,835-39 ft. TD 9,015 ft. (New pay in Southwest Hardin field.)

Matagorda County: Tide Water Associated Oil Co. 1 Slaughter, Sec. 21, R. Lawder Sur., A-351. IP 231.18 BOPD, 7/64-in., 46.4°, perforations 10,118-10,180 ft. TD 10,270 ft. (New field.)

San Patricio County: Plymouth Oil Co. 9 Ficke, S½ of NW¼ Sec. 50. IP 143 BOPD, 9/64-in., 43.1°, perforations 5,951-53 ft., and (dual completion) 94 BOPD, ⅛-in., 43.7°, perforations 5,868-70 ft. TD 6,775 ft. (New pay—5,951-53 ft.—in East White Point field.)

SOUTHWEST TEXAS

Hidalgo County: Shell Oil Co. 1 Works, Block 1, Jackson Subd., El Melado Grant. IP 4,900 M.c.f. daily, open-flow potential, 4 BC per M.M.c.f., perforations 7,390-7,408 ft., and (dual completion) 5,200 M.c.f. daily, open-flow potential, 8 BC per M.M.c.f., perforations 7,562-82 ft. TD 9,758 ft. (New field—Oblate area.)

Jim Wells County: L. M. Lockhart et al 1 Hoffman, Los Presenos de Abajo Sur., A-171. IPP 40 BOPD, 22.7°, perforations 5,171-75 ft. TD 5,785 ft. (New field—Wiley Ballard.)

EAST TEXAS

Harrison County, new pay in Elysian Fields: R. T. Harris 1 Mercer Unit, 43°, Pettit 6,295-6,305 ft. TD 6,503 ft., elev. 311 ft. First oil well in field.

Panola County: Crescent Corp. 1 Agurs, James Shandoin Sur., gas-distillate discovery in Bethany field, ½ mi. N Bethany. IP 3,000 M.c.f. gas, plus 21 bbl. 57.5° distillate per 1,000 M.c.f., "D" zone of Cotton Valley 8,544-76 ft. TD 8,652 ft.

NORTH TEXAS

Denton County: Felderhoff Bros. Drilling Co. 1 Knowles, James Tiller Sur., A-1283, 2 mi. SW Sanger. IP 40 BOPD, ½-in., 40°, TP 75 psi., GOR 600, pay 1,691 ft. TD 1,696 ft.

Wilbarger County: Neeld & Hood 1-E Waggoner, Sec. 3, H&GN, 1½ mi. W production. IPP 25 BOPD, 38°, GOR 300, pay 1,620-38 ft. TD 2,496 ft.

Young County: O. P. Leonard 1 Morrison, N. F. Tracy Sur., A-1639, 2 mi. NE Bunger, IP 2,000 M.c.f. gas, 1-in. choke, TP 400 psi., pay 4,082-87 ft. TD 4,450 ft.

Rankin & Karper 1-B Holcomb, R. J. Fisher Sur., A-95, 7 mi. W Graham. IP 192 BOPD, 14/16-in., TP 870 psi., 42°, GOR 460, Mississippian pay 4,480 ft. TD 4,488 ft.

WEST TEXAS

Andrews County: Lindsley, Holbrook and George 1 Argo, 22-A41-PSL, 12 mi. SW Andrews. IPP 133 BOPD, 35°, GOR 320, top San Andres pay 4,244 ft. TD 4,515 ft.

Crane County: Gulf Oil Corp. 210 Waddell, 14-B23-PSL Sur., 17 mi. NW Crane, new pay (Pennsylvanian) in Waddell field. IP 784 BOPD, 62/64-in., 40.5°, GOR 523, TP 90 psi., top pay 8,300 ft. TD 10,150 ft.

Crockett County: Slick Oil Co. 1 Weger, Sec. 49, GC&SF, 9 mi. S Big Lake. IPP 93 BOPD, 30°, pay 2,282 ft. TD 2,870 ft.

Garza County: Seaboard Oil Co. and Republic Natural Gas Co. 2-A Ranch, Sec. 3, A-529, J. Holmes, F. Divers and A. J. & F. Long Sur., 14 mi. E Post. IPP 44 BOPD, 32°, GOR 90, pay 2,666 ft. TD 8,170 ft.

Irion County: Sunray Mid-Continent Oil Co. 1-A Ella Sugg, 95-14-H&TC, 7 mi. N Barnhart. IP 334.47 BOPD, no water, 18/64-in., TP 420 psi., GOR 700, 38.8°, Clear Fork pay 4,535 ft. TD 4,900 ft.

Scurry County: Revilo Royalty Co. 1 Eastman, 300-97-H&TC Sur., 12 mi. NW Snyder. IPP 75 BOPD, 34°, Clear Fork 2,624 ft. TD 2,764 ft.

Tom Green County: G. W. Strike 2 Baker, W. J. Skinner Sur. No. 2, 14 mi. N San Angelo. IP 266 BOPD, 16/64-in., 47.6°, TP 800 psi., GOR 1538, Strawn 6,398-6,408 ft. TD 6,703 ft.

Yoakum County: John W. Murchison & Meredith Mowery 1 Cook, 83-D-J. H. Gibson Sur., 11 mi. NE Plains. IPP 178 BOPD, 40°, GOR 110, Pennsylvanian pay 9,496 ft. TD 9,989 ft.

WYOMING

Carbon County, Medicine Bow: McElroy Ranch, Bruce Anderson, Natural Gas & Oil Corp. 4 Horne Bros., SW NE SW 11-20n-79w. IPP 84 BOPD, Tensleep discovery, new pay. TD 7,844 ft. Tensleep.

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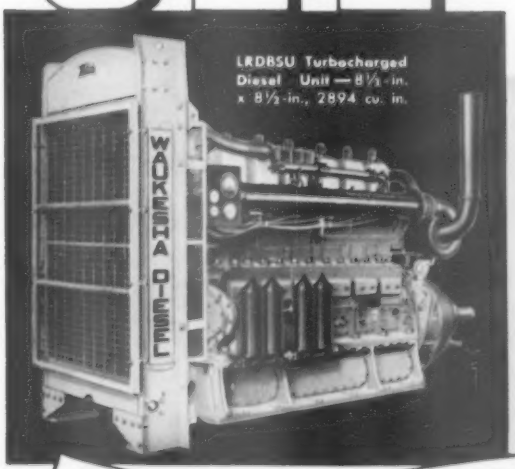

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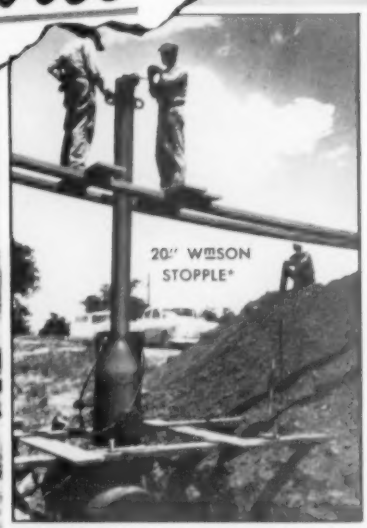

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Cuban Commuter

Siboney and Crescent jobs keep Ben Hurlbutt hopping

TWELVE hundred miles is a long way to commute to work, But that's what Ben Hurlbutt is doing.

He has become a familiar figure on airline flights from Tulsa to Havana this year. In fact, it is hard to find him at his Tulsa office, where he is chief geologist for Crescent Corp. and president of Siboney Development Co. This commuting is making him a stranger to his wife, Josephine, and four children.

In his new role as head of Siboney, he has stepped beyond the realm of geology and into the maze of administrative detail involved in negotiating a foreign exploration concession and putting a program into effect.

Now, after a year of arranging financing, surveying disputed boundaries, and mapping surface geology and subsurface structures, Siboney is ready to drill its Cuban concession.

The first wildcat will test the thick Tertiary sediments in southern Camaguey Province, south of the Jatibonico discovery which spurred the exploration play now covering the entire island and surrounding offshore territory.

Originally, Siboney was jointly owned by Crescent and Sterling Oil of Oklahoma, Inc., another Tulsa firm. It was committed to spend $2,000,000 and drill 36,000 ft. of hole to earn half interest in the concession with Caribbean Petroleum Associates, Inc.

But a new deal gives Siboney 100 per cent working interest and much greater flexibility of operation. It now will be able to drill the most promising locations. It will not have to waste time and money on a certain area just to fulfill contract requirements.

In return for its interest, Caribbean Petroleum was paid $250,000 in cash and 2,500,000 shares of Siboney stock, increasing capitalization to 7,500,000 shares.

The concession is the largest in Cuba held by an independent. It covers 5,000,000 acres stretching over basins in southern Cuba from one end of the island to the other. A large block is in the shallow waters of the Gulf of Batabano. It is these areas, many geologists feel, that hold the future of Cuba's oil industry.

Background . . . Ralph Benson Hurlbutt was born December 29, 1915, in Stamford, Conn., the son of a securities investor.

He was graduated from the Choate School in 1934. He attended Amherst for 2 years before being lured to the oil country and heading southwest.

After 2½ years of geological studies at Southern Methodist University, he joined Republic Natural Gas Co. at Dallas. Hurlbutt was geologist for Republic's Kansas district when he left in 1946 to become a partner in the Ben Franklin Exploration Co., Shreveport.

He sold his interest 2 years later and went into the consulting business on his own in Shreveport. After 3 years as an independent, he joined Deep Rock Oil Corp. in Shreveport as area geologist. Hurlbutt was chief geologist when Deep Rock sold its refining and marketing properties this spring to Kerr-McGee Oil Industries, Inc., and started rebuilding under the name of Crescent Corp.

Crescent now is concentrating on the producing end of the oil business, using its capital to acquire proved and semiproved properties. Exploration at this time is confined to Cuba. This takes up about 90 per cent of Hurlbutt's time, and he's confident this venture will pay off.

"Cuba has all the requirements for an oil province," he says. He feels that the discovery of sedimentary basins and the existence of source beds indicate important pools are waiting to be found there. And when they are found, Hurlbutt believes some of them will have to be on Siboney's far-flung acreage.

Brig. Gen. Will W. White, former vice president of Esso Export Co., will retire shortly as director of the Defense Department's Division of Petroleum Logistics. General White will be succeeded by **Brig. Gen. Louis Cotulla,** an army regular, now deputy director of logistics for U. S. forces in Europe. General White, an Air Force reservist, will end 2 years' active duty next February 8. He took the defense job in 1954 for 1 year, but was persuaded to stay another 12 months.

James C. Taylor, development engineer for Shell Oil Co. in Salt Lake City, has been transferred to the company's Long Beach office. Other Shell transfers include **Ivan P. Colburn,** development engineer at Ely, Nev., to the

KIRBERG DORSEY JUSTICE KUHNE SIECKE

Gulf Names Five to New Posts

Gulf Oil Corp. has announced five promotions in its manufacturing department in Pittsburgh. **E. J. Kirberg,** former process manager of department, has been named coordinator. Besides aiding Gulf vice presidents in carrying out refining plans and policies, Kirberg will coordinate refining activities with those of other departments. **B. R. Dorsey,** who formerly managed Gulf's Venezuela refinery, is new administrative assistant to Vice President B. H. Barnes. He will deal with refinery operations, crude supply, and product demand. **R. S. Justice,** formerly manager of the construction and maintenance division, has become chief engineer of the newly created engineering division. **P. K. Kuhne,** who was assistant manager, technical division, has been promoted to director of the product division. **Paul Siecke,** who was assistant process division manager, has been named chief process engineer. He will deal with process evaluation and design.

PERSONALS

Los Angeles area office; **Sam J. Ieronimo,** Salt Lake City development engineer, to Ventura, Calif.; and **Thomas R. Schmidt,** mechanical engineer, from Houston to Ventura.

R. E. Kellerman, recently general manager of Texas Crude Oil Co., Dallas, has been named a new partner of that firm. Kellerman joined the company in 1952 after stints with Dowell, Inc., Shell Oil Co., and Republic Natural Gas Co.

Nichols J. Campbell, Jr., has been elected a vice president of Creole Petroleum Corp. Now manager of the law department in Caracas, Venezuela, Campbell will assume the new post early next year.

G. A. Severson, former assistant manager of the Colombian division of Texas Petroleum Co., has been promoted to division manager. He succeeds **J. O. Bower,** recently elected vice president and manager of Colombian Petroleum Co. and South American Gulf Oil Co., both Texaco affiliates. Severson has served in various Texaco posts in Venezuela, Argentina, and New York.

James C. Bell has joined the engineering staff of Corrosion Services, Inc., Tulsa. He formerly was with Service Pipe Line Co., and National Lead Co.

R. V. Chase, manager of Gulf Oil Corp.'s Salt Lake City exploration area, has been named exploration manager for the Casper area. He replaced **H. D. Bedford,** recently appointed Rocky Mountain zone manager of exploration. **Jack Hanson,** former area landman in Salt Lake City, assumed Chase's old post.

L. C. Foy, operations supervisor for Sinclair Pipe Line Co., has been promoted to assistant general manager of crude pipe lines. Foy formerly was assistant manager of Sinclair's Mid-Continent crude pipeline division. That post will be filled by **Ralph W. Sexton,** now assistant district superintendent of the company's Great Bend, Kans., crude lines operating division.

Nat C. Robertson, petrochemicals director for National Research Corp., Cambridge, Mass., has been named director of research for Escambia Bay Chemical Corp., Shreveport. He will remain for a time directing research already underway at the Cambridge company. During World War II, Robertson did special research in synthetic rubber for Standard Oil Development Co. From 1947 to 1951, he headed a physical chemistry research group for Celanese Corp. of America.

Ross Phar has been promoted to assistant vice president of Skiles Oil Co., Mount Carmel, Ill. Phar joined Skiles in 1948, and for the past 15 months has supervised the production and land departments.

Henry J. Ramey, Jr., former senior resident engineer for Magnolia Petroleum Co., has been transferred to General Petroleum Corp. at Los Angeles as production engineer. Ramey will work on the Belridge thermal-recovery test.

H. HANSEN

Harold Hansen, British - American Oil Producing Co., has been promoted from field engineer at Sterling, Colo., to district engineer at Midland. **John Freeman,** staff engineer, has been transferred by the company from Midland to Sterling. Hansen joined British - American in June 1953 after 7 years in South America as a petroleum engineer.

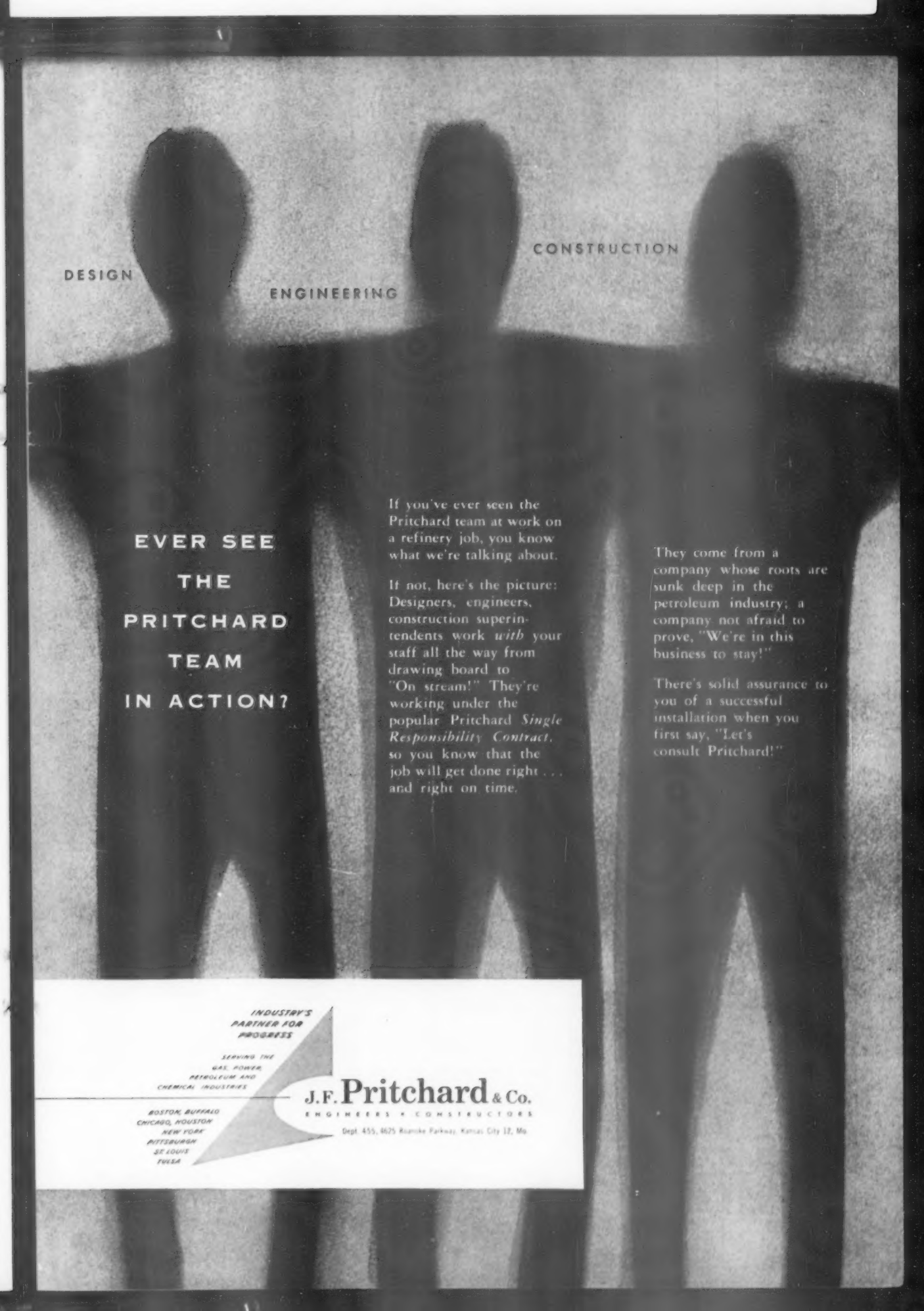
A. L. Lyth has been transferred from Jackson, Miss., to Casper, Wyo., to be district superintendent for California Company's Wyoming district. **H. O. Woodbury,** former district exploration superintendent at Casper, has been moved to New Orleans as evaluations geologist.

Grover J. Holt, general manager of ore-mining at Cleveland-Cliffs Iron Co., Ishpeming, Mich., has been named president-elect of the American Institute of Mining and Metallurgic Engineers. Holt takes over the reins in 1957. Elected vice presidents were **Lloyd E. Elkins** and **J. L. Gillson.** Elkins is production research director for Stanolind Oil & Gas Co., Tulsa. Gillson, of Evansville, Ill., is a development geologist for E. I. du Pont de Nemours & Co., Wilmington.

J. W. Webb, Calgary, has been named department manager and exploration manager of Canadian Oil Companies, Ltd.'s new producing department at Calgary. Two other officials will join Webb to make up an executive committee responsible for operation of the new department. They are **H. G. Bagnall,** operations manager,

New A.A.P.G. Slate Installed

Mason L. Hill, chief geologist for Richfield Oil Corp., and newly elected president of American Association of Petroleum Geologists, heads the slate installed at A.A.P.G.'s thirty-second annual meeting in Los Angeles recently. The new officers are, left to right, Hill; Loyde H. Metzner, assistant chief geologist, Signal Oil & Gas Co., vice president; Thomas A. Baldwin, senior geologist, Monterey Oil Co., secretary; and Everett W. Peace, chief geologist, Sunray Mid-Continent Oil Co., treasurer.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PERSONALS

and **W. M. Luthy,** development manager, Webb and Bagnall are former executives of Anglo-Canadian Oil Co., a company recently bought out by Canadian.

Dan Duncan has joined Thomas P. Pike Drilling Co., of Los Angeles, as assistant to the drilling superintendent, **W. G. Klassen.**

J. G. Montfort has been named field superintendent of Southern Pacific Pipe Lines, Inc., with headquarters at Colton, Calif.

N. C. Eakin, gas pipeline manager for Mountain Fuel Supply Co., Rock Springs, Wyo., will retire, effective next month.

Richard F. Brown, vice president and general works manager of Spencer Chemical Co., has resigned to join another firm in the nitrogen business. Brown's post will be filled by **John C. Denton,** until now general manager of engineering and construction at Spencer. Denton joined the company in 1942, and has served as manager of its Henderson, Ky., works.

Arizona Joins Compact

Gov. Ernest W. McFarland signs the document making Arizona the twenty-sixth full member of the Interstate Oil Compact Commission. Watching him are Lawrence R. Alley, left, assistant executive secretary of the commission from Oklahoma City, and Hubert Merryweather, right, vice president of Valen Oil & Minerals Corp., McFarland's representative on the commission.

Ross L. Shipman has resigned as district subsurface geologist for Humble Oil & Refining Co. at Midland, Tex., to become a consultant there. Shipman had been with Humble 5 years.

J. L. Schmidt, general production superintendent and assistant to the president, East Ohio Gas Co., has been named gas supply manager for Consolidated Natural Gas System. He will assume the new post January 1, with headquarters at Gateway Center, Pittsburgh. Schmidt, who joined Consolidated in 1927, will be in charge of production, transmission, and storage for the entire system.

M. W. (Bill) Goering, district geologist for Amerada Petroleum Corp. at Williston, N. D., has been transferred to Casper, Wyo., as the firm's district geologist in Wyoming and South Dakota. **K. W. (Bill) Roth** replaces Goering as district geologist for the northern Rockies.

Ray C. Conkling, superintendent of light oils division at the Standard Oil Co. (Ind.) Casper refinery, will retire this week after 40 years' service with Standard. Conkling's post will be filled by **George Jones,** promoted from assistant superintendent of the same division at the company's Whiting, Ind., refinery. **B. T. Allison,** general foreman of heavy oils division at the Casper refinery, has been moved to Standard's Chicago headquarters as light oil operations supervisor.

William McCarthy, former vice president and general manager of McCarthy Oil & Gas Corp., Houston, and brother of Glenn McCarthy, has been named president of Texas-Adams Oil Co., independent of New York and Denver. **Worth Pettit, Jr.,** former vice president of Prudential Federal Savings and Loan Association, Salt Lake City, was elected board chairman. McCarthy also is president of Sundown Oil Co. of California, Sundown Oil Co. of Colorado, and American Montane Oil & Gas Corp.

J. Addison, former secretary of Iranian Oil Participants, Ltd., has been named general manager of the firm. He replaces **H. E. Snow,** who has been reappointed a managing director of British Petroleum Co., Ltd. Snow has managed I.O.P. since the company's formation last year. Addison has been in close touch with Middle East oil activity since he joined B.P. in 1946. **K. L. Le Page** has been appointed secretary of I.O.P.

J. A. Cantes has been promoted to district superintendent of Hiawatha Oil & Gas Co. at Greenville, Ky. Cantes was field superintendent at Uniontown, Ky.

W. I. Durant, former drilling and production superintendent with American Liberty Oil Co. in Casper, Wyo., and **Francois DeGunzburg,** Denver independent, have formed D&D Drilling Co., with offices in Denver. Durant will conduct operations from Casper.

DEATHS

Luther C. Turman, a pioneer in West Texas oil development, died recently at Fort Worth. As a young man, Turman was among the first successful wildcatters in Upton, Crane, and Winkler counties, Texas, and helped organize the Independent Petroleum Association of America.

Max Neuhaus, Houston, vice president for research and development of Jefferson Chemical Co., died recently in a Houston hospital. He was 48. Before joining Jefferson in 1944, Neuhaus did research work for Humble Oil & Refining Co. and The Texas Co. He held a doctorate of science in chemical engineering from Massachusetts Institute of Technology.

Russell C. Conkling, 58, Midland, Tex., geologist and operator, died recently while vacationing in Eureka Springs, Ark. Conkling joined Shell Oil Co. in 1922 and served a variety of assignments for that firm before resigning to become an independent in 1935. He later worked for Phillips Petroleum Co. and was chief geologist for Plymouth Oil Co. In 1952, he joined his sons to form a Midland drilling firm.

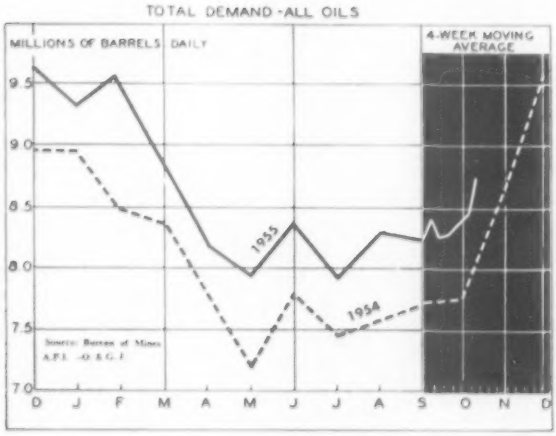
Fred H. Podmore, 59, manager of the marketing department, construction and maintenance operations, for Richfield Oil Corp., died recently in his Alhambra, Calif., home. He had been with Richfield 26 years.

Bill Holcomb, 20, a driller for McConnell Drilling Co., Dallas, was killed November 12 in a rig accident near Waskom, Tex. Holcomb's home was at La Rue.

Latest Figures . . . Industry Trends

A QUICK LOOK AT THE HIGHLIGHTS

	LATEST WEEK	Change from WEEK AGO		Change from YEAR AGO	
Production	6,799,775	UP	24,325	UP	480,130
Crude stocks	256,685,000	DOWN	829,000	DOWN	13,717,000
Completions	1,182	UP	49	UP	149
Refinery runs	7,553,000	DOWN	8,000	UP	670,000
Gasoline stocks	152,084,000	UP	80,000	UP	4,188,000
Distillate stocks	150,606,000	DOWN	1,382,000	UP	14,447,000
Residual stocks	45,761,000	DOWN	171,000	DOWN	10,307,000
Four-product stocks	384,213,000	DOWN	2,155,000	UP	7,315,000
Total imports	1,132,400	DOWN	144,000	UP	96,300



First Real Winter Weather Brings Strength to Distillate Markets

COLDER weather and higher tanker rates are giving strength to the East Coast distillate market. Suppliers of the upper part of the East Coast granted a voluntary allowance on distillate heating oils, amounting to 0.5 cent a gallon, last May. It was generally understood in this marketing area that the allowance would be withdrawn at the start of the heating season or about the first of October.

The big increase in distillate inventories prevented the normal return to winter prices at the first of October or even the first of November. However, increased buying, under the influence of colder weather and higher shipping costs, has added strength in most of this high-demand area.

Some marketers are predicting that the allowance will be removed before Thanksgiving. The current net barge price for No. 2 fuel in New York Harbor is 9.55 cents a gallon. When the 0.5-cent allowance is withdrawn, the price of 10.05 cents would be only 0.1 cent a gallon above the 9.95 cents quoted for this fuel for most of last winter.

Spot rates on clean tankers in the Gulf-East Coast trade have advanced sharply in the past weeks. Current fixtures are 40 to 50 per cent above the Maritime Commission base rates. A week ago quotations were at USMC flat, and a month ago movement from the Gulf Coast to the East Coast carried a quotation of 15 per cent off the base rate.

This advance in tanker rates means that it now costs at least 0.5 cent a gallon more for a spot movement of No. 2 fuel from the Gulf to the East Coast than it did a month ago. The Gulf Coast low quotation for No. 2 plus increased transportation cost to the East Coast totals more than the low quotation for barge delivery in New York Harbor. Since the Gulf Coast market is gaining strength, the situation calls for an immediate increase in East Coast prices.

Most of the secondary suppliers on the East Coast are keeping their tanks filled to take advantage of the price increase. Consumer demand, under the influence of colder weather, will tend to keep the market firm for some time after the increase. The combination that could cause a later break in prices is continued high distillate production and warm weather in late December and January.

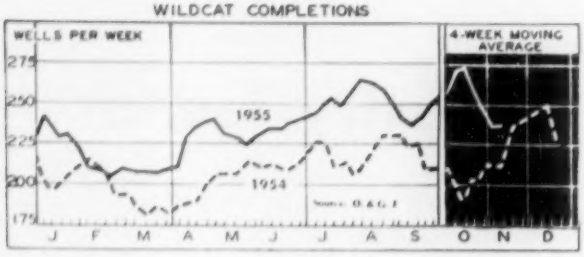
Movement of distillate fuels is increasing in the North Central states. Use of heavy fuel is gaining in areas where industrial and power plants on interruptible gas contracts are shifting fuels.

Continental Oil Co. raised the tank-wagon prices for regular and premium gasolines in Oklahoma and premium gasoline in New Mexico, effective November 14. Some Oklahoma suppliers still had not met the increase on November 16. There has been no change in the Group 3 quotation on gasoline for northern shipment.

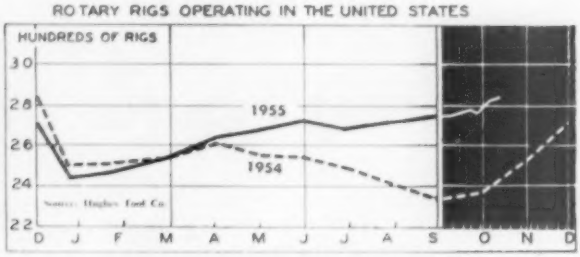
There have been rumors of an impending increase in tank-wagon prices for gasoline in the North Central states, but none has been announced so far.

Gasoline demand has been very good, but it will take widespread tank-wagon gains to boost the Group 3 spot price.

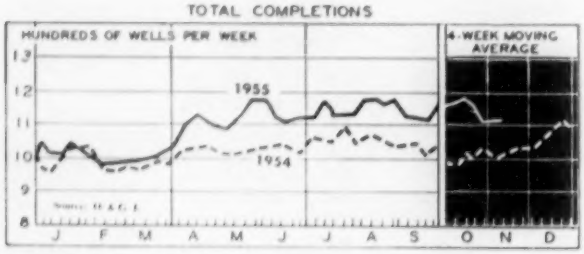
WILDCAT COMPLETIONS



ROTARY RIGS OPERATING IN THE UNITED STATES



TOTAL COMPLETIONS



ACTIVE ROTARY RIGS*

Area	11-14-55	Change from 11-7-55	Change from 11-15-54
Gulf Coast	602	3	54
N. and W. Texas-New Mexico	972	17	174
Arkansas-N. Louisiana-E. Texas	171	—5	—15
Oklahoma	367	3	51
Kansas-S. Nebraska	193	5	18
Illinois-Eastern	134	0	—14
Rocky Mountain	265	0	14
Pacific Coast	145	3	3
Total United States	2,849	26	285
Western Canada	199	—2	4

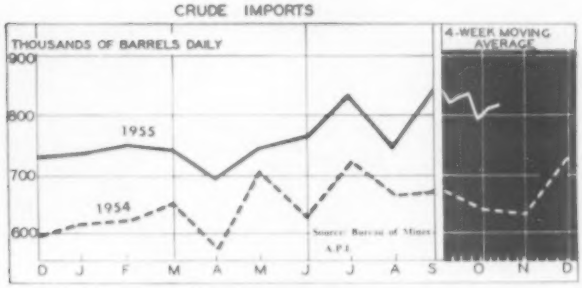
*Hughes Tool Co.

WEEKLY WELL COMPLETIONS . . . WEEK ENDED NOVEMBER 12, 1955

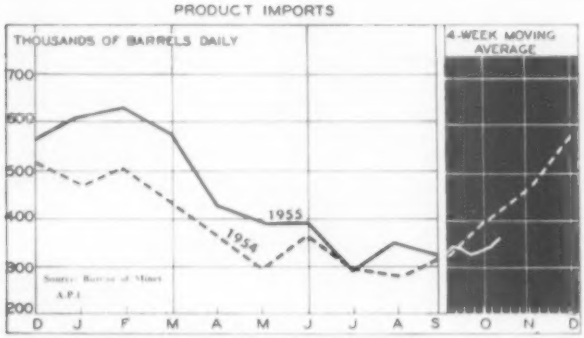
	Total of all wells: Comp.	Oil	Gas	Dry	Footage	Cum. 1955	Cum. 1954	Wildcat completions and discoveries: Oil	Dist.	Gas	Dry	Total	Cumulative total, 1955: Oil	Dist.	Gas	Dry	Total
Ala.-Ga.-Fla.	1	0	0	1	3,702	66	92	0	0	0	1	1	1	0	0	63	64
Arkansas	18	12	0	6	52,666	702	529	1	0	0	1	2	32	1	4	147	184
California	37	20	0	17	185,268	2,103	2,040	1	0	0	16	17	39	0	11	384	434
Colorado	26	12	1	13	132,968	1,295	1,134	3	0	0	9	12	43	0	22	634	699
Illinois	90	47	0	43	193,316	3,369	2,519	2	0	0	10	12	61	0	4	478	543
Indiana	13	4	0	9	22,619	624	721	0	0	0	6	6	11	0	0	235	246
Kansas	92	41	8	43	335,198	4,342	3,905	3	0	1	22	26	123	1	31	731	886
Kentucky	51	27	6	18	66,843	1,376	1,005	2	0	0	11	13	51	0	9	287	347
Louisiana	65	36	7	22	500,552	3,475	2,984	0	1	0	13	14	100	72	28	402	602
North	26	13	6	7	105,103	1,790	1,625	0	0	0	4	4	22	11	4	168	205
South	39	23	1	15	395,449	1,685	1,359	0	1	0	9	10	78	61	24	234	397
Michigan	3	0	0	3	7,412	458	492	0	0	0	2	2	11	0	1	177	189
Mississippi	13	4	0	9	91,163	397	362	0	0	0	7	7	14	0	0	144	158
Montana	3	3	0	0	20,725	344	289	0	0	0	0	0	13	0	1	129	143
Nebraska	24	7	0	17	126,938	768	380	1	0	0	14	15	39	0	1	319	359
New Mexico	43	18	19	6	184,889	1,478	938	2	0	0	3	5	37	2	10	99	148
Northwest	21	2	18	1	85,142	509	329	2	0	0	1	3	7	1	10	29	47
Southeast	22	16	1	5	99,747	969	609	0	0	0	2	2	30	1	0	70	101
North Dakota	6	4	0	2	45,312	225	263	0	0	0	1	1	6	0	0	56	62
Ohio	30	13	4	13	56,067	1,049	1,011	0	0	0	0	0	3	0	7	16	26
Oklahoma	207	134	6	*67	606,964	7,377	7,643	1	1	0	9	11	124	16	25	572	737
Pennsylvania-New York	26	8	10	†8	46,562	1,311	1,960	0	0	0	0	0	0	0	7	10	17
Texas	397	250	14	133	1,858,578	17,450	15,985	18	3	3	86	110	674	96	114	3,578	4,462
Southwest (1 & 4)	59	31	4	24	217,840	2,697	2,229	2	0	1	16	19	103	30	35	690	858
Gulf Coast (2 & 3)	46	22	2	22	324,363	2,193	2,263	4	2	1	16	23	81	53	36	583	753
East (5 & 6)	10	6	1	3	59,099	842	842	1	1	0	1	3	22	5	9	282	318
North Central (7-B & 9)	132	79	2	51	446,943	6,489	6,100	3	0	1	32	36	321	0	15	1,406	1,742
West (7-C & 8)	124	90	2	32	727,393	4,309	3,717	8	0	0	21	29	142	1	10	586	739
Panhandle (10)	26	22	3	1	82,940	920	834	0	0	0	0	0	5	7	9	31	52
Utah	0	0	0	0	0	79	77	0	0	0	0	0	6	0	6	49	61
West Virginia	20	2	14	4	51,642	567	530	0	0	0	0	0	0	0	10	18	28
Wyoming	16	8	1	7	78,224	788	1,080	1	0	0	3	4	24	0	7	184	215
Miscellaneous (Ariz.)	1	0	1	0	6,382	58	113	0	0	1	0	1	4	0	3	46	53
Total United States	**1,182**	650	91	441	4,673,990	49,701	46,052	35	5	5	214	**259**	1,416	188	301	8,758	10,663
Total previous week	1,133	612	79	442	4,592,965			29	5	5	212	251	1,381	183	296	8,544	10,404
Total November 13, 1954	1,033	552	81	400	4,254,582			32	4	10	186	232	1,241	122	347	7,806	9,516
Western Canada	80	60	15	5	382,102												

Service wells included: *6, †5.

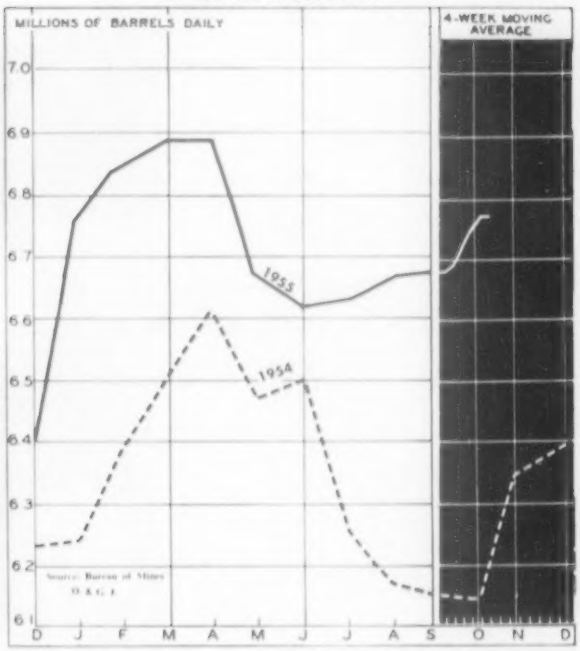
CRUDE IMPORTS



PRODUCT IMPORTS



CRUDE-OIL PRODUCTION

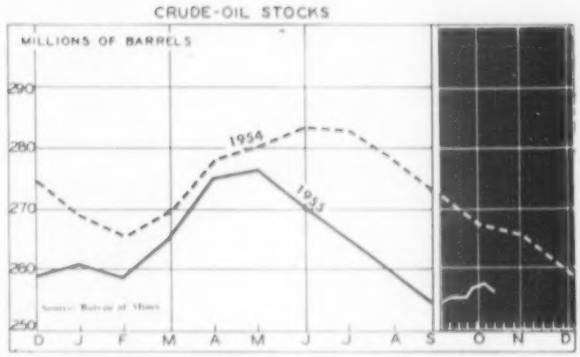


DAILY AVERAGE PRODUCTION FOR WEEK

	November 12			Nov. 5
	Crude oil	Lease condensate	Total	total
Alabama	4,100		4,100	4,000
Arkansas	74,150	450	74,600	74,350
California	973,800		973,800	973,100
Colorado	149,500		149,500	151,500
Eastern	52,100		52,100	52,100
Florida	1,350		1,350	1,350
Illinois	229,200		229,200	231,200
Indiana	30,000		30,000	29,800
Kansas	316,900		316,900	317,900
Kentucky	44,000		44,000	43,800
Louisiana	702,850	58,000	760,850	757,300
North	112,850	3,000	115,850	115,300
South	590,000	55,000	645,000	642,000
Michigan	31,900		31,900	32,000
Mississippi	105,600	4,700	110,300	109,150
Montana	41,700		41,700	40,600
Nebraska	27,400		27,400	30,200
New Mexico	228,900	3,550	232,450	§231,075
North Dakota	20,400		20,400	19,100
Oklahoma	536,300		536,300	544,800
Texas	2,834,200	50,925	2,885,125	2,854,725
Dist. 1	54,000	525	54,525	52,800
Dist. 2	151,400	7,975	159,375	156,075
Dist. 3	408,000	24,500	432,500	432,500
Dist. 4	239,000	5,150	244,150	243,300
Dist. 5	48,500	425	48,925	50,000
Dist. 6	125,000	5,300	130,300	129,575
East Texas field	219,500		219,500	216,500
Dist. 7-B	149,000	50	149,050	149,050
Dist. 7-C	170,000	4,300	174,300	172,150
Dist. 8	965,000	2,000	967,000	951,475
Dist. 9	214,800	500	215,300	211,100
Dist. 10	90,000	200	90,200	90,200
Utah	5,400		5,400	6,300
Wyoming	272,300		272,300	270,900
Others	‡100		‡100	‡200
Total U. S.	6,682,150	117,625	**6,799,775**	§6,775,450
Change from previous week, up			**24,325**	
Canada	†356,050		†356,050	†375,225
Total U. S. production January 1-November 12			2,129,604,925 bbl.	
Same period last year (crude plus cond.)			*2,003,714,465 bbl.	

*Includes 30,759,675 bbl. cond. †Week ended previous Monday. ‡Nev. 100. §Revised.

CRUDE-OIL STOCKS

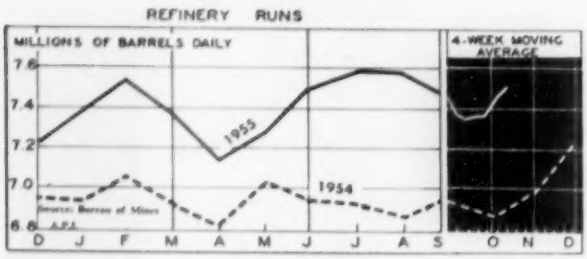


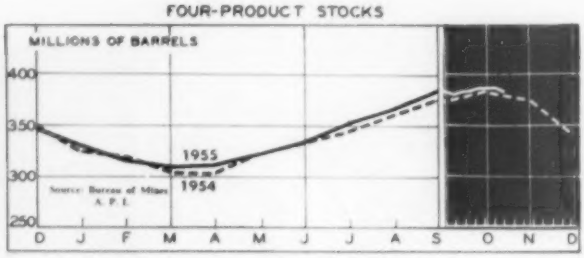
CRUDE-OIL STOCKS BY STATES OF ORIGIN*

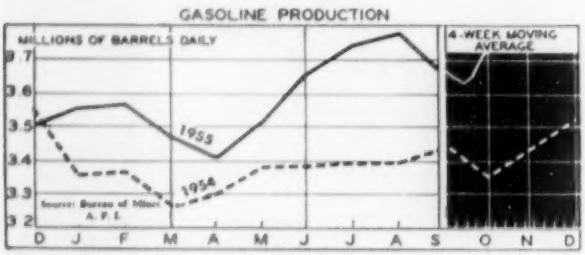
(Thousands of barrels)

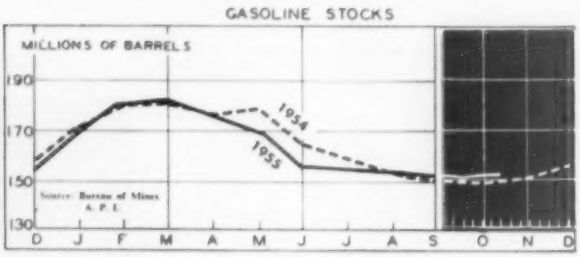
	11-5-55	10-29-55	11-6-54
Pennsylvania Grade	3,147	3,206	3,237
Other Appalachian	1,765	1,867	2,028
Illinois, Indiana, Michigan	9,147	9,401	12,263
Nebraska, North Dakota	2,350	2,574	1,820
Kansas	8,108	8,083	8,703
Oklahoma	20,781	20,932	26,824
Arkansas	2,472	2,328	3,003
Louisiana	15,813	15,913	14,359
North	3,018	2,483	2,337
South	12,795	13,430	12,022
Mississippi	3,127	3,057	3,004
New Mexico	7,289	7,305	8,699
Texas	122,281	121,838	124,809
East Texas proper	9,023	9,521	11,186
West Texas	57,261	57,190	56,427
Texas Gulf	25,352	25,505	24,587
Other Texas	30,645	29,622	32,609
Wyoming	14,661	14,808	12,889
Other Rocky Mountain	5,843	5,832	5,921
California	27,290	27,132	32,066
Foreign	†12,611	13,238	10,777
Total	256,685	257,514	270,402

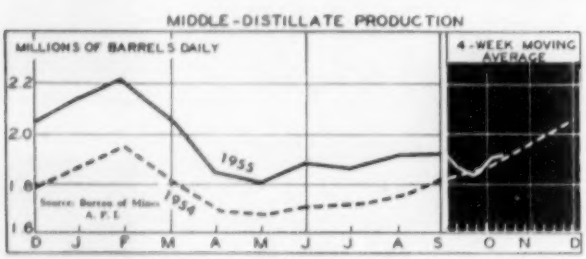
*Bureau of Mines. †Includes 2,163,000 bbl. in California.

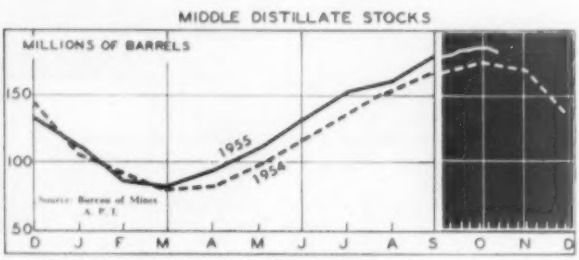


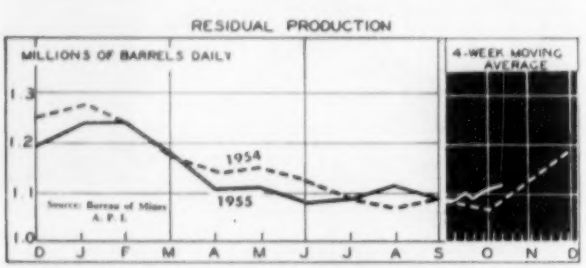


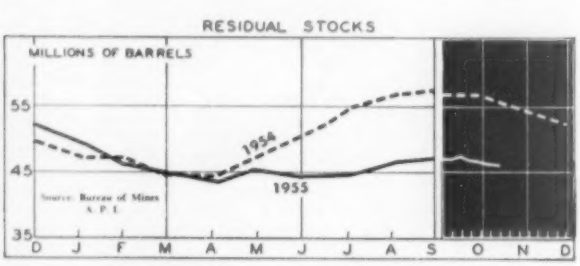

GASOLINE PRODUCTION
MILLIONS OF BARRELS DAILY
4-WEEK MOVING AVERAGE
1955
1954
Source: Bureau of Mines A.P.I.
D J F M A M J J A S O N D




MIDDLE-DISTILLATE PRODUCTION
MILLIONS OF BARRELS DAILY
4-WEEK MOVING AVERAGE
1955
1954
Source: Bureau of Mines A.P.I.
D J F M A M J J A S O N D




RESIDUAL PRODUCTION
MILLIONS OF BARRELS DAILY
4-WEEK MOVING AVERAGE
1954
1955
Source: Bureau of Mines A.P.I.
D J F M A M J J A S O N D



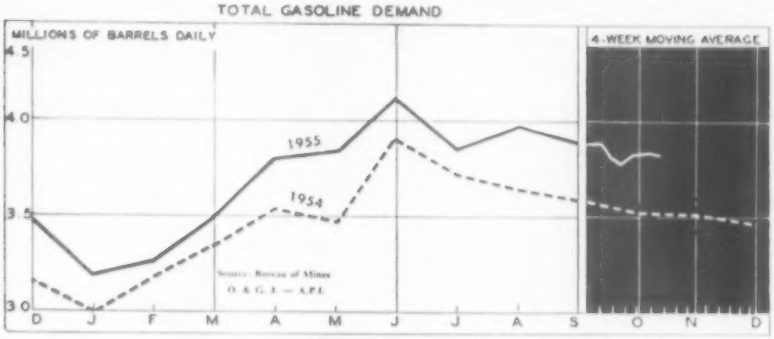
A.P.I. REFINERY REPORT, NOVEMBER 11

(Thousands of barrels)

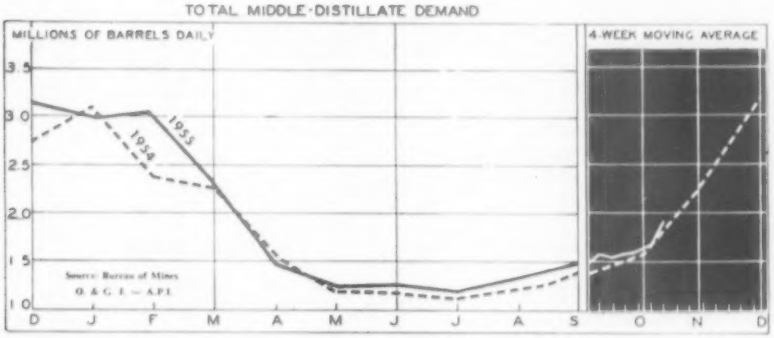
District—	Daily avg. runs	Daily average production Gaso.*	Kero.	Dist.	Resid.	Stocks‡ Gaso.†	Kero.	Dist.	Resid.	Bureau of Mines, November 1954 Daily avg. runs	Daily average production Gaso.*	Kero.	Dist.	Resid.
East Coast	1,076	427.4	31.0	229.0	197.3	36,063	15,008	57,406	13,106	989	417.6	28.7	267.6	194.4
Appalachian														
District 1	114	47.4	6.6	21.0	8.0	4,462	697	3,217	558	93	44.0	5.3	19.9	6.5
District 2	84	51.7	6.4	14.4	14.3	2,321	562	1,204	452	74	33.4	5.9	12.4	8.4
Ind., Ill., Ky.	1,291	687.0	54.0	258.2	163.3	30,797	8,723	29,298	5,055	1,267	670.6	77.6	264.8	168.5
Okla., Kans., Mo.	698	397.4	20.1	153.6	31.4	14,466	2,355	15,478	1,501	623	352.6	17.4	160.7	38.0
Inland Texas	251	190.2	11.3	45.1	21.3	5,461	487	2,965	1,341	224	176.9	9.2	40.9	22.6
Texas Gulf Coast	1,936	869.7	137.1	471.4	256.9	19,793	3,093	16,906	7,003	1,754	824.0	128.7	443.9	233.5
La. Gulf Coast	666	361.3	45.9	144.4	39.0	8,553	2,849	6,008	1,234	603	311.7	64.8	164.5	39.7
N. La. and Ark.	96	37.3	6.4	23.9	6.1	3,670	1,225	2,265	80	88	38.0	7.4	22.5	6.6
Rocky Mountain:														
New Mexico	22	11.0		4.0	2.9	227	5	49	28	20	11.2	0.7	3.1	3.1
Other Rocky Mtn.	249	115.2	1.7	59.0	40.7	4,914	350	2,831	878	227	108.5	3.9	53.7	33.6
California	1,070	491.0	4.9	160.4	336.7	21,357	408	12,979	14,525	1,013	439.9	4.4	168.2	364.9
Nov. 11, 1955	7,553	3,686.6	325.4	1,584.4	1,117.9	152,084	35,762	150,606	45,761	6,975	3,428.4	354.0	1,622.2	1,119.8
Nov. 4, 1955	7,561	3,776.1	330.1	1,670.1	1,153.7	152,004	36,444	151,988	45,932					
Nov. 12, 1954	6,883	3,451.6	313.9	1,629.9	1,121.4	147,896	36,775	136,159	56,068					

*At refineries including natural blended. †Finished and unfinished. ‡At refineries, bulk terminals, in transit, and in pipelines.

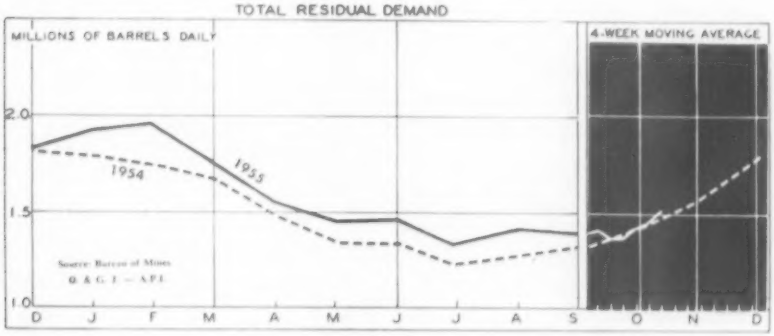
TOTAL GASOLINE DEMAND



TOTAL MIDDLE-DISTILLATE DEMAND



TOTAL RESIDUAL DEMAND



REPRESENTATIVE QUOTATIONS

Spot-market quotations of leading suppliers as of November 16, 1955. Prices are in cents per gallon, except for residual in dollars per barrel and wax in cents per pound.

GASOLINE, KEROSINE, AND FUEL OILS

	Mid-Continent Group 3	New York Harbor (barge)	Texas Gulf Coast
Regular gasoline	11-11.25	11.5-12	10.5-10.75
Premium gasoline	12.5-12.75	13-13.75	12-12.25
42-44 w.w. kerosine	9.25-9.50	10.05	8.75-9.00
No. 2 straw fuel oil	8.25-8.50	9.55	8.5-8.75
No. 6 residual	$1.75-1.85	$2.55-2.75	$2.10-2.20

NATURAL GASOLINE

	Group 3	North Texas	N. La.
Grade 26-70	6.0	5.5	5.75
Grade 18-55	7.2	6.7	6.95

LUBRICATING OILS

Mid-Continent

150-160 vis., D bright stock, 0-10 pp.	19
200 vis., No. 3 neutral, 0-10 pp.	14.25

WAX

Mid-Continent

132-134 A.M.P.	0.6

● Colder weather in the North Central area has increased sales of distillate fuels. As the cold air mass moves to the east, demand will increase on the East Coast. Gulf-East Coast delivery cost for distillate is up about 0.5 cent a gallon. Tank wagon prices for gasoline were raised in Oklahoma by Continental Oil Co., effective November 14.

PRODUCTION AND DEMAND—MAJOR PRODUCTS

(Thousands of barrels daily)

	Refinery prod.	Total demand
Gasoline:		
Four weeks ended 11-11-55	3,764	3,818
August 1955	3,858	4,033
October 1954	3,362	3,515
November 1954	3,428	3,505
Middle distillate:		
Four weeks ended 11-11-55	1,919	1,929
August 1955	1,910	1,377
October 1954	1,854	1,509
November 1954	1,976	2,247
Residual fuel:		
Four weeks ended 11-11-55	1,123	1,519
August 1955	1,090	1,439
October 1954	1,066	1,429
November 1954	1,120	1,560

CRUDE PRICES GRAVITY SCHEDULE

	Signal Hill, Calif.*	Okla-homa, Kansas	Gulf Coast Tex.†	West Tex.‡
14-14.9	$1.97			
15-15.9	2.03			
16-16.9	2.09			
17-17.9	2.15			
18-18.9	2.21			
19-19.9	2.27			
20-20.9	2.33	$2.50		$2.37
21-21.9	2.39	2.52		2.39
22-22.9	2.45	2.54		2.41
23-23.9	2.51	2.56		2.43
24-24.9	2.57	2.58	$2.91	2.45
25-25.9	2.63	2.60	2.93	2.47
26-26.9	2.69	2.62	2.95	2.49
27-27.9	2.76	2.64	2.97	2.51
28-28.9	2.83	2.66	2.99	2.53
29-29.9	2.91	2.68	3.01	2.55
30-30.9	2.97	2.70	3.03	2.57
31-31.9	3.04	2.72	3.05	2.59
32-32.9	3.12	2.74	3.07	2.61
33-33.9		2.76	3.09	2.63
34-34.9		2.78	3.11	2.65
35-35.9		2.80	3.13	2.67
36-36.9		2.82	3.15	2.69
37-37.9		2.84	3.17	2.71
38-38.9		2.86	3.19	2.73
39-39.9		2.88	3.21	2.75
40 and above		2.90	3.23	2.77

*Standard Oil Co. of California. †Upper Texas Gulf Coast. ‡Sour. Includes New Mexico Permian.

Effective dates. California, October 17, 1955; east of California, June 15, 1953; Pennsylvania Grade, November 1, 1955.

FLAT CRUDE PRICES

Representative posted schedules per barrel

Louisiana:	
Cotton Valley (distillate)	$3.00
Cotton Valley (Holloway crude)	2.95
Texas:	
East Texas	2.90
Chapel Hill	2.83
Conroe	3.13
Van	2.73
Pennsylvania Grade:	
Bradford	3.75
Middle District	3.62
Southwest Pennsylvania	3.33
West Virginia	3.21
Buckeye Grade	3.15
Zanesville Grade	2.87
Illinois Basin	3.00

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GARDNER-DENVER two-stage gas compressor unitized unit powered by 250 H.P. Buda motor and all equipment, gauges and coolers necessary to operate. All in first-class condition. Gulf Southwest Service Co., P. O. Box 1328, Shreveport, La. Telephone 2-8428.

CORE DRILLS, SPUDDERS, ROTARIES. New and used equipment. Everything in supplies. Fishing tools rented. Pressey & Son, Pueblo, Colo.

FOR SALE: Used R. L. Cardwell Drilling-in Unit. Splendid condition with all accessories and large Doghouse. Located near Wichita. Phone or write John Richard, McClelland Hotel, Wichita, Kansas; or write Box 361, Topeka, Kansas.

FOR SALE: National T-12 rig on 32' Tandem Trailer, 145 HP Motor, complete except drill pipe. First class condition, approx. 8 months old. Box J-233, The Oil and Gas Journal, Tulsa, Oklahoma.

FOR SALE—At Tallant, Oklahoma, three 5' x 56' Absorbers, 20 Trays, 24" Spacing 500# WP, peak design each 40,000 MCFD at 350 PSIG; Oil Rate 100-300 GPM, min. and max. Bought new 1947, taken out of service 1954. Price $8500.00 each, now standing. Full data upon request. Cities Service Oil, Patridge, Bartlesville, Oklahoma.

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ARMITE LABS., 6500 Broad St., Los Angeles 1, Calif.
Petro. Industries Consultants, C.A. Caracas, Venez.

NEW TRAILERS

DROP—BED "TYPE" $2,731.48
FLAT—BED "TYPE" 2,638.89

Plus 6% Tax

Built To Order

PASKO MACHINERY & STEEL
1721 CHICAGO DRIVE S. W.
GRAND RAPIDS, MICHIGAN

FOR SALE
12" Line Pipe

(IMMEDIATE DELIVERY)

200,000 ft. 12¾" O.D. x .375 Wall, 49.56#, Lapweld, All Machine Cleaned, Straight, App. 20' SRL, Ends Beveled, Used Good Condition

SUITABLE FOR
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Piling or Structural Use

Located: Kansas and Missouri

Large additional quantities same size available soon from present take up and reconditioning operations in Missouri.

Priced Attractively for Prompt Shipment

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SALES AND RENTALS. Used cable drilling and fishing tools, casing, production equipment; from the Southwest's largest stock of oil field supplies. Degen Pipe and Supply Co., Tulsa.

FOR SALE—5000' Drilling Rig—Complete for South Texas Drilling—Completely Overhauled—For Price and Complete Inventory write—McKENZIE DRILLING COMPANY, 717 WILSON BUILDING, CORPUS CHRISTI, TEXAS.

SEISMOGRAPH CABLE TRUCK with special "Sewall" body using 5 cable handlers (Squirts) and 5 cable bins, mounted on 1952 Dodge Power Wagon. Excellent Condition. Texas Seismograph Company, Box 2069, Wichita Falls, Texas.

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Plant capacity 10 MMSCF/D with operating pressure of 600 psig. The absorber designed for 800 psig. Built new four years ago, complete with gasoline and L.P.G. storage. Plant can be easily moved.

BOX J-251,
THE OIL AND GAS JOURNAL,
TULSA, OKLAHOMA.

Gasoline Plant Equipment For Sale

3—800# 20 MMCF Absorbers with scrubbers, etc.
2—150 HP 350# WP Lucey Oil Country Boilers Complete with Stacks, etc., and Steel Building.
1—30" x 62' Depropanizer with Accumulator, Reboiler and Condenser.
1—Fluor "Counterflo" Induced Draft Cooling Tower Complete.

Other equipment, Instruments, Pumps, Pipe, Valves and Fittings necessary in Gasoline Plant Construction. Detailed Inventory Available upon request.

SOUTHERN PRODUCTION COMPANY, INC.,
P. O. Box 670, Phone FAnnin 8103,
Fort Worth, Texas

FOR SALE EQUIPMENT

USED CATERPILLAR Motor D4 600, good condition; new Kobe 7" pump; three used 7" Lucas pumps. Delivery Falls City, Nebraska. Write: Box 231, Scarsdale, N. Y.

ATTENTION Drilling Contractors—FXQ—7¾x16 Gardner-Denver fluid ends complete. Perfect condition, for sale or trade. Contact: Wichita Pipe & Supply Co. P. O. Box 1803, Wichita Falls, Texas. Phone: 3-8197.

STAR 45 SPUDDER, 61' steel mast, casing blocks, 2500' ⅞" drilling line, ⅝" sand line, Tools 15" to 5", except 6", also fishing tools. D8800 Caterpillar motor, motor in A1 condition. $5,500.00. Late 1949 F6 Ford truck, Tulsa winch, homemade oilfield bed, jin poles, blocks chains, 8,500 miles, $1,550.00. 1949 F5 Ford truck, 6 cyl., oilfield bed, jin poles blocks, chains, 13,700 miles, $1,150.00. O. K. Unruh, Rt. 3, Madison, Kansas.

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8" LINE PIPE
LAPWELD 8⅝" O.D. 28.55

Very good No. 1 grade, used pipe. Straight 20' single random lengths machine cleaned.
Choice of plain end or T&C. Ideal for oil, water and gas systems, 850 to 900 psi.
Pipe located in Illinois, with low barge, rail and water rates to any part of the world. Priced below market, selling at almost ½ cost of equivalent new pipe.
Will sell for cash or will finance meritorious propositions.

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IMMEDIATE DELIVERY

400,000 ft. 8⅝" O.D. x .322 Wall, 28.55#, Lapweld, All Machine Cleaned, Straight, App. 20' SRL, Ends Beveled, Used Good Condition.

3,000—8-V Thread Used Couplings, suitable shopping. 8⅝" O.D. Pipe.

SUITABLE FOR
Oil, Water, or Gas Systems,
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Located: Kansas and Missouri

Large additional quantities same size available soon from present take up and reconditioning operations in Missouri.

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We have been awarded the Cabin Creek Refinery by the Pure Oil Corporation, Charleston (Cabin Creek) West Virginia. The entire manufacturing and processing machinery and equipment of this modern plant is for sale.

A complete catalogue of the major components is now being prepared and a copy will be mailed on request. Here is an opportunity to avail yourselves of unusual bargains in Refinery Equipment and supplies.

Before dismantling begins we suggest you visit plant and select units from the largest list of Refinery Equipment offered in recent years.

6,000 BBL. TOPPING; 3,000 BBL. THERMAL CRACKING; 100 BBL. CATALYTIC POLYMERIZATION; LUBE OIL & PARAFFIN WAX PLANT; RERUN UNIT—STORAGE TANKS—BOILER HOUSE; INSTRUMENTS, ETC.

Every item will be sold at a fraction of original cost—Anticipate your needs and save money—visit the plant—salesman on premises. Write for catalogue.

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Roy Crisp—Manager—Charleston, West Virginia

FOR SALE—13⅜" Seamless Steel casing couplings, new, prime, perfect, 8 Rd. Thd. Quantity very attractive price. Box J-224, The Oil and Gas Journal, Tulsa, Oklahoma.

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FORMER LACY REFINERY,

BIG SANDY, TEXAS

COMPLETE POLY UNIT, BUILT 1950

1—Wyatt 30" x 70' Stabilizer 160# 30 tray
3—Absorbers, 14" x 40', 20" x 50', 160#
2—Wash Towers, 18" x 23', 150#
1—Reactor, 24" x 28', 550#
1—Depropanizer, 20" x 35', 450#
1—Debutanizer, 12" x 26', 120#
3—Brinkman vertical tube furnaces 3.5, 2, 1¼ mil. BTU/hr.
30—Brown fintube exchangers, 600# 11, 21, 77, 101, 140 sq. ft.
3—Adm. heat exchangers 424, 346, 176 sq. ft.
2—Perco reactors 4500 gal., 8' x 12', 347 stls. st. 120#, 1000° F.
1—5' x 96' tower, 40 tray, 135# WP
1—7' x 30' Propane tank, 250# WP
1—10' x 50' Crude tower, 18 trays
1—6' x 34' Vacuum tower, 150#
1—2' x 50' tower, 24 trays
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3—St. exchs., 2000, 1500, 480 sq. ft.
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3—Penn. comp. 8 x 11 x 9, 12 x 11½ x 13, 10 x 6 x 11
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1—Waukesha anti-knock machine
8—Hi-vol pumps, 10 x 7 x 18, 10 x 6 x 12, 6 x 4 x 12, 6 x 3 x 8
30—Duplex piston pumps, all sizes
1—10' x 30' asphalt still
6—Steel Bldgs., 20 x 150, 12 x 20, 20 x 40, 20 x 20
2—Pritchard cooling towers, Adm. Bentube exchanges
1—BS&B Oil & gas separator, 10.7 mcf, 3500 Bbl./day.

COMPRESSOR STATION—BALT., MD.

3—600 hp IR KVG Gas Comp.
1—MWK 2400 sq. ft. adm. exch. 150#

FINAL LIQUIDATION, LEVELLAND, TEX.

1—42' x 49' stabilizer, 180#, 28 tray
1—42" x 49' stabilizer, 180#, 28 tray
5' x 40' ch lined vessel, 90#
30,000 ft., 4, 6 in. pipe
5,000 ft. 2", 4", 4-6 ch pipe

EQUIPMENT ELSEWHERE

COLUMNS

7' x 115' 50 tray
8' x 75' 25 tray 40#
2' x 60' 35 tray 560#

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6—Adm. 785, 742, 425 sq. ft.
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30—304 SS shell & tube condensers 100-1000 sq. ft.

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Lab Petro-chem furnace 50,000 BTU/hr.
Gould 4" Pump 400 gpm 1600' hd
B-J hot oil pump 3 x 9, 13 st. 325 gpm, 4620' hd
Gould 16" pump 10,500 gpm, 135' hd.
Tremendous selection stainless steel and steel valves ½" - 6"

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4101 San Jacinto St., Houston 4, Texas, JA 6-1151
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EMSCO 250 RIG, complete with Emsco double mast. Excellent condition. 4,000-ft. practically new, 4½-in. drill pipe. Rig now running. Bargain. Phone FOrest 8-5886, 421 Meadows Bldg., Dallas, Tex.

FOR SALE: Complete Oilfield manufacturing, machine shop and supply business. Write W. N. Young, Box 977, Ada, Oklahoma.

I WILSON TITAN DRAWWORKS 40 double hydromatic brake, three L-3000 Le Roi gas engines, two pump drives. 1—8"x20" Gardner-Denver slush pump with Rod oiler and V-Belt sheave. For prices of this equipment write P. O. Box 497 or phone MAdison 6-7344, Tulsa.

GAS METERS: Foxboro, Emco and Westcott Orifice Meters for sale. Geo. R. Milner, Box 124, Okmulgee, Okla.

3500 FT. Wilson Rotary Rig complete. Air controlled. 3200 ft. 4½ F. H. Drill Pipe. 4 Drill Collars. 7¼x10 FXO Gardner-Denver Pump. All Butane equipped. Call #2 or #411, Cleveland, Oklahoma, RIverside 7-0658, Tulsa, Okla.

TWO BUCYRUS-ERIE 36L's complete. Also string, 15-inch down, big-hole tools. Tut-Tilley, Wewoka, Okla.

FOR SALE: 2 Type 80 Cooper Twin Gas Engine Driven Compressors rebuilt like new ready to go. Compressor Cylinders to suit. Write or phone W. S. Smith, 205 Thompson Bldg., Tulsa, Okla. LUther 2-5473.

COMPLETE ROTARY RIG, 2000 to 4500 feet capacity. 3500 feet 4½" drill pipe, 7¼ x 14 pump, powered by 1335 Buda and 350 H.P. V-8 Le Roi Engines. Price, $25,000. Phone DIamond 3-0369, Tulsa, Okla.

Gaso Duplex 4½" x 6" Power Pumps with Chrysler C-36 Engines, skid mounted, immediate delivery. Also Byron Jackson, Carter Centrifugal Units, Westinghouse 20-25-50 KW Generating Units.

H. H. COFFIELD
Attn.: W. H. ORR
Phones: 132—Rockdale, Texas
AT-3427—Houston, Texas

FOR SALE

NEW SLIM HOLE TRAILER MOUNT RIG

CAPACITY: 6700' w/4"—7700' w/3½"—10,000' w/2⅞"

Bethlehem S-45-E drawworks—G. M. Twin Diesel Motors—Lee C. Moore 94' mast mounted on triple axle tandem assembly also 8'-8" sub-structure. Bethlehem 225—8" x 14" pump w/ G. M. Twin Diesel Motors—Bethlehem 510—5½" x 10" auxiliary pump w/ G. M. Single Diesel motor—6500' new grade E drill pipe—6 drill collars—never rigged up—ready to go—can be purchased at considerable saving—shown by appointment.

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Telephones 2-2212 and 2-6896

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FOR SALE—At our Arkansas City Gasolene Plant—1—31"x61'3" Tulsa Boiler Stabilizer, 35 trays, ¾" flange quality plate shell, ASME code welded, 160# WP at 350° F stress relieved, with 3'x8' Jacking Engineering reboiler, two Alco 8"x84" and 168" heat exchangers, lowered, lot price $5000.00. Cities Service Oil, Patridge, Bartlesville, Oklahoma.

FOR SALE—At our Arkansas City, Kansas Gasolene Plant, 3—4'x53"9' Tulsa Boiler Type welded absorbers, 20 trays, ⅞" flange quality plate, ASME code welded 400# WP at 120° F., with piping. Lowered, each $6500.00. Complete data upon request. Cities Service Oil, Patridge, Bartlesville, Oklahoma.

5000 FEET used 8⅝", 28#, T&C Casing; 7500 feet used 2" T&C Line Pipe. Delivered to your location. FADEM PIPE & SUPPLY CO., 325 Mayo Building, Tulsa, Oklahoma. GIbson 7-8068.

ELI DRILL M6D-164-D on 1948 Ford New Motor, good rubber, 22' Mast, 13' Kelley, 4½ x 5 G-D Pump, 150' Rod, slush pit and bit subs. SeisDrill, Inc., 515 Thompson Bldg., Tulsa, Oklahoma.

FOR SALE: Autocar Diesel C-100, 1949 model. Dual tandem with Braden C-90 winch, in excellent condition, worth the price. Contact Phone #740, or write P. O. Box #346, Sullivan, Indiana.

FOR SALE—At our Wichita gasolene plant, 901 West McArthur Road, 1—6'x8' Vertical Flint Steel Corp. Gas Scrubber with 3 Trays Mist Extractor, Shell 1⅝", Heads 1⅛" Code Welded, stress relieved, design max. WP 400# PSI. Max temperature 100° F. New 1948. $2500.00. Cities Service Oil, Patridge, Bartlesville, Oklahoma.

WANT EQUIPMENT: Did you find the equipment you wish to purchase in this column? If not, use an "Equipment Wanted" classified advertisement to find it. It is available somewhere and Journal classified advertisements will find it. See box heading for classified rates, or write The Oil and Gas Journal.

FOR SALE

Practically new Unit-40 drilling rig now operating in West Central Texas. Completely equipped with Moore 136' Heavy Duty Jack knife Derrick, LRO Waukesha power, National C-250 pump and all other accessories. No Brokers. If interested write

Box J-250,
The Oil and Gas Journal,
Tulsa, Oklahoma.

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Million Dollar Inventory

ARMY SURPLUS TRUCKS - TRAILERS

open and closed type; Low Boys quarter ton to sixty ton including Mack Tandem Diesel; International Gas Tandems; Jeeps; Quarter ton Jeep Trailers; 4x4 Dodge Pickups; 4x4 Dodge closed ambulances; 6x6 GMC's with 1350 gallon gas tanks; Half Tracks with and without winches; Tandem Axle assemblies suitable for all heavy duty Trucks; Dump Bodies and a large stock of parts for all military type trucks and trailers.

ALL THE ABOVE OBTAINABLE AT ONE LOCATION . . .

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FOR SALE substantially below mill price 50,000 lbs. new Tubes, 70% Copper, 30% Nickel, ¾" O.D. x .049" Wall. Lengths: 9', 9'2", 12'6", 12'8". Hugo Neu Corporation, 31 Nassau St., New York 5, N. Y.

FOR SALE: Bucyrus-Erie Model 24L spudder, complete with core bbl., light plant, large and small tools for top to bottom drilling. Call or write Geo. H. Wickham. Phone 4551, Box 505, Grayville, Illinois.

SELLING 2 completely equipped wells, jacks, motors, pipeline tanks, perfect condition, eastern Kansas. Jox J-252, The Oil and Gas Journal, Tulsa, Oklahoma.

EQUIPMENT WANTED

14-IN. MUD PUMP and motor and other rotary equipment for 4,500 ft. Tut-Tilley, Wewoka, Okla.

USED TOOL JOINTS for 2⅞" EUE tubing Either 8 or 10 thread. W. H. Doran Jr. Box 648, Alice, Texas.

HELP WANTED

WANTED as Sales Representatives. Retired drilling engineer, familiar with mud problems and drilling. Attractive offer. Exclusive territory. P. O. Box 4183, Station A, San Antonio, Texas.

HELP WANTED

SEISMOGRAPH Computer. Must be experienced and free to travel. Box J-234, The Oil and Gas Journal, Tulsa, Oklahoma.

MAJOR OIL COMPANY has immediate openings for two geologists with Mid-Continent experience. Address Box J-202, The Oil and Gas Journal, Tulsa, Oklahoma.

GRADUATE PETROLEUM ENGINEER—Oil company has opening at Midland, Texas, for aggressive field production engineer, under 38 years of age, with minimum of two years' West Texas experience plus proven ability in testing, drill stems, workovers and completions. P. O. Box 3053, Dallas, Texas.

STAFF ENGINEER—Major gas pipeline company in Rocky Mountain area has opening for staff engineer in operating department who has an engineering degree, preferably B.S. in Mechanical Engineering. Two years experience with major engine manufacturer or operating company in engine testing research and development required. Job will consist of planning and conducting tests on compressor engines, to check load and fuel consumption and performance. Should be familiar with technical apparatus used in testing work, make reports and studies of the tests with any recommendations to improve performance or efficiency. Box J-235, The Oil and Gas Journal, Tulsa, Oklahoma.

HELP WANTED

FOREIGN EMPLOYMENT. List of oil companies and drilling contractors showing where to apply for foreign jobs. OIML Co., Box 2603, Tulsa, Okla. $5.00 cash.

DISTRICT GEOLOGIST wanted by established oil company for employment in West Central Texas Area. Must have performed the administrative duties of the position and have from seven to ten years of practical geological experience, preferably in the area mentioned. Salary will be commensurate with ability and experience. Reply should state age, education, experience and starting salary desired, and interview will be arranged only upon receipt of such personal data. All replies will be treated in confidence. Our employees know of this advertisement. Reply Box J-220, The Oil and Gas Journal, Tulsa, Oklahoma.

DISTRICT GEOLOGIST

Durango, Colorado office. Must have degree. Ten to twenty years experience in Rocky Mountain area desirable. Capable of supervising personnel and assuming complete geological responsibilities pertaining to drilling and production of wildcat operations. Salary open, age limit 45 years. Contact

REYNOLDS MINING CORP.

1911 Melrose Bldg.,
Houston, Texas.
Phone CApitol 8-8286.

PETROLEUM ENGINEER

Durango, Colo., office Must have degree. Eight to ten years experience in Rocky Mountain area desirable. Capable of supervising personnel and assuming complete responsibility pertaining to drilling and production of wildcat operation. Salary open. Age limit—47. Contact:

Reynolds Mining Corp.

1911 Melrose Bldg.
Phone CApitol 8-8286
Houston, Texas

ESTIMATORS

Experienced in Process Equipment and piping costs, for Chemical Plant & refinery construction. Position offers good future with progressive Penna. firm. Send resume to

T-95, P. O. BOX 3495
Philadelphia 22, Pa.

SALES ENGINEERS

Capable of representing country's leading manufacturer of engines for oil field pumping and other auxiliary services. Excellent opportunity for high caliber man. Headquarters Tulsa, territory Mid-Continent. Opening immediately. Please give transcript of experience, and state salary expected. All replies will be treated confidentially.

Box J-209, The Oil and Gas Journal, Tulsa, Oklahoma.

SALES REPRESENTATIVES WANTED:

Manufacturer of Oil-Gas Separating, Treating, and Metering Equipment wants commission Sales Representatives for (1) North Texas (2) East Texas, Southern Arkansas, Northern Louisiana (3) South Texas (4) Texas Panhandle (5) Williston Basin (6) Illinois, Indiana, Kentucky (7) California (8) Canada. Territories available on exclusive contract basis to qualified and experienced men. Please give details concerning present sales coverage, lines handled, and sales personnel when answering.

Box J-231, The Oil and Gas Journal,
Tulsa, Oklahoma

ENGINEERS

MECHANICAL
ELECTRICAL
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A large crude oil pipe line company, operating within Oklahoma, has openings for Engineering graduates. Diversified, interesting and permanent employment with advancement opportunities. Experience not essential, but a reasonable knowledge of hydraulics, office and field work in the design of crude oil pipe lines and pump stations is desirable. Submit resume and salary requirements including a recent snapshot to—

Box J-249,
The Oil and Gas Journal,
Tulsa, Oklahoma.

DESIGN ENGINEERS

Permanent Opportunities With

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In Our REFINERY, METALS or INDUSTRIAL Divisions
at our
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McKEE with more than 50 years of successful operation, doing business all over the world; is one of the largest, oldest and best known engineering and contracting firms in the business. The McKEE organization continues to grow and expand, thereby offers many present and future opportunities for qualified and experienced engineers and designers in the following fields:

PIPING STRUCTURAL STEEL CONCRETE PROCESS HEATERS EQUIPMENT SPECS.
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Applicants should have at least five years' of experience.

Here is a rare opportunity for you to utilize your engineering abilities and talents.

McKEE offers top compensation commensurate with experience and ability. No age limitations.

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DRILLING EQUIPMENT ENGINEER

Foreign Service

With degree in Petroleum or Mechanical Engineering, plus minimum of 5 years' experience in the design, manufacture, use and maintenance of drilling equipment and supplies. A knowledge of the various drilling equipment manufacturers and their products necessary. Salary dependent upon experience and qualifications.

Write giving full particulars regarding personal history and work experience. Please include your telephone number.

Recruiting Supervisor, Box 74

ARABIAN AMERICAN OIL COMPANY

505 PARK AVENUE, NEW YORK 22, NEW YORK

HELP WANTED

POSITION AVAILABLE

REFINERY SUPERINTENDENT AND ASSISTANT TO THE MANAGER

for new refinery recently completed in Western Canada. Must have at least three to five years Asphalt Refining experience. Salary open. Reply in detail giving educational background, refinery experience, together with three industry and three personal references. Please enclose picture.

Address replies to

REFINERY OFFICE,
Room 611, Northern Hardware Building,
Edmonton, Alberta, Canada.

HELP WANTED

INDEPENDENT oil and gas company desires to hire petroleum engineer to supervise production and well completion of gas and oil properties in East Texas, Louisiana immediate opening. All replies confidential. Box J-228, The Oil and Gas Journal, Tulsa Oklahoma.

SITUATIONS WANTED

GEOPHYSICIST—Nineteen years seismic experience. Thoroughly experienced in supervision of crews in Rocky Mountain and Mid-Continent areas. Box J-236, The Oil and Gas Journal, Tulsa, Oklahoma.

EXECUTIVE Petroleum Engineer-Geologist, 35, employed, registered. Seeks challenging position with independent, drilling contractor, or transmission company. Eleven years active varied experience with major and independent in Kansas, Oklahoma, and Texas. Box J-229, The Oil and Gas Journal, Tulsa, Oklahoma.

GEOLOGIST, Nineteen years' experience Oklahoma, Texas and San Juan Basin. Eleven years as District Geologist. Able to supervise Geological Department. Box J-188, The Oil and Gas Journal, Tulsa, Oklahoma.

INDEPENDENT or middle size oil company, college graduate, 27, one year law, two years major oil company Land experience in Gulf Coast, Louisiana and Texas, commercial multi-engine pilot. Capable of assuming dual flying-land position. Box J-227, The Oil and Gas Journal, Tulsa Oklahoma.

SITUATIONS WANTED

PRACTICAL RESERVOIR ENGINEER, 8 years diversified experience in completions, workovers, reservoir valuations and secondary recovery, desires opportunity to increase production for aggressive operator. Box J-243, The Oil and Gas Journal, Tulsa, Oklahoma.

PETROLEUM ENGINEER with over 10 years drilling and production experience in Southern Louisiana. Desire affiliation with progressive organization. Box J-244, The Oil and Gas Journal, Tulsa, Oklahoma.

ACCOUNTANT: Age 32, Married, College Graduate. Five years diversified experience with major oil company. Desire position with independent or small oil company. References. Box J-222, The Oil and Gas Journal, Tulsa, Oklahoma.

PETROLEUM ENGINEER - GEOLOGIST, fifteen years diversified experience in reservoir engineering, production operations and supervision. Desires position with progressive small company or independent. Box J-214, The Oil and Gas Journal, Tulsa, Oklahoma.

DESIRES RESPONSIBLE Oil Executive Position. Degrees B.S. Petroleum Geology, B.B.A., Major Personnel Management, also Petroleum Engineering, Oil and Gas Law. Experience in Seismograph Subsurface Geology, 5 years Oil and Gas Taxation with Federal Government. Box J-215, The Oil and Gas Journal, Tulsa, Oklahoma.

BUSINESS OPPORTUNITIES

BUSINESS OPPORTUNITIES

FOR LEASE OR LEASE-PURCHASE FLOATING DERRICK "AJAX" 250 TON CAPACITY

Owners are interested in making long term lease or lease purchase arrangement for 250 ton capacity full revolving derrick on 90' x 150' barge with living quarters. Entire unit in condition like new.

For additional information contact

SOUTHERN SCRAP MATERIAL CO., LTD.
421 N. Carrollton Ave.,
New Orleans, La.

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BUSINESS OPPORTUNITIES

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Inquiries Invited

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WANTED

OIL PROPERTIES WANTED. "Oil properties wanted, settled or semi-settled production of 100 to 2,500 barrels daily in Oklahoma and Kansas. Property must stand thorough inspection. Contact Morris Sitrin, 1215 First National Building, Tulsa, Oklahoma with particulars.

LEGAL

U. S. DEPARTMENT OF THE INTERIOR, Bureau of Land Management, Land Office, Billings, Montana. Notice is hereby given that approximately 292.03 acres of land in three parcels: Parcel 1: sec. 4, Lots 3, 4, 5, 6, 7 containing 110.38 acres; Parcel 2: sec. 5, Lots 1, 4, 5, 7 containing 141.65 acres; Parcel 3: sec. 9, SW¼ SW¼ containing 40 acres, all in T. 129 N., R. 106 W., 5th P. M., North Dakota, and within the known geologic structure of Cedar Creek Field, North Dakota, will be offered for oil and gas leasing through competitive bidding to the qualified bidder of the highest cash amount per acre at 2:00 p. m., M.S.T., January 25, 1956, when bids will be opened. The successful bidder(s) will reimburse the Bureau of Land Management for their proportionate share of the publication costs of this sale. Details of the lease offering and how and where to submit bids, may be obtained from the Manager of the Land Office, 1245 North 29th Street, Billings, Montana. Orval G. Hadley, Manager, Land Office.

LEGAL

U. S. DEPARTMENT OF THE INTERIOR, Bureau of Land Management, Land Office, Billings, Montana. Notice is hereby given that the following described land located in Montana and within the known geological structure of the fields identified will be offered for oil and gas leasing through competitive bidding to the qualified bidder of the highest cash amount per acre. CUT BANK Field, Glacier County, Parcel No. 1, T. 34 N., R. 6 W., P. M., Mont., Sec. 22, Lot 2 containing 31.66 acres; Parcel No. 2, T. 33 N., R. 6 W., P. M., Mont., Sec. 3, Lot 1 containing 4.05 acres. KEVIN-SUNBURST field, Toole County; Parcel No. 3, T. 35 N., R. 1 W., P. M. Mont., Sec. 33, W½ SW¼ containing 80 acres; Parcel No. 4, T. 34 N., R. 2 W., P. M., Mont., Sec. 6, S½ NE¼, SE¼ containing 240 acres; Parcel No. 5, T. 35 N., R. 3 W., P. M. Mont., Sec. 27, SW¼ NE¼, SE¼, E½ SW¼ containing 280 acres; Parcel No. 6, T. 35 N., R. 3 W., Sec. 34, NW¼ NE¼, NE¼ NW¼ containing 80 acres. BOWDOIN Field in Valley County, all land in T. 31 N., R. 35 E., P. M., Mont. and subject to provisions of special stipulation identified as Section 3g: Parcel No. 7, Sec. 15: NE¼ SW¼ containing 40 acres. Parcel No. 8: Sec. 21, W½, W½ E½, SE¼ SE¼ containing 520 acres. Parcel No. 9: Sec. 30; all, containing 640 acres. Date of the sale is 10:00 A. M., M.S.T., January 25, 1956, when bids will be opened. The successful bidder(s) will reimburse the Bureau of Land Management for their proportionate share of the publication costs of the sale. Details of the lease offering, special stipulations, how and where to submit bids, may be obtained from the Manager, Land Office, 1245 North 29th Street, Billings, Montana. Orval G. Hadley, Manager, Land Office.

LEGAL NOTICE

NOTICE OF SALE OF INTERESTS IN PRODUCING OIL AND GAS PROPERTIES

Notice is hereby given that the undersigned, Wm. B. Prugh and J. D. Land, Trustees of OKLAHOMA-TEXAS TRUST, an Express Trust organized under the laws of the State of Oklahoma, will offer for sale at public auction and sell to the highest bidder, for cash, the interests of Oklahoma-Texas Trust, an Express Trust, in producing oil and gas properties located in the States of Kansas, Oklahoma, and Texas, on the 12th day of December, 1955, at 11 o'clock A. M., in the office of Oklahoma-Texas Trust at 907 Kennedy Building, Tulsa 3, Oklahoma.

All interests of the Trust in producing oil and gas properties located in each state will be combined and sold as a single unit. The interests of the Trust to be sold are as follows:

TEXAS:

12 Producing Wells in East Texas Field—Full ⅞ths W. I

OKLAHOMA:

5 Producing Wells in Oklahoma City Field—Full ⅞ths W. I.
3 Producing Wells in Oklahoma City Field—Various Interests

KANSAS:

19 Producing Wells in Barton County, Kansas—Various Interests
2 Producing Wells in Russell County, Kansas—7/32nds of 7/8ths of ⅞ths W. I.

Wells located in Barton and Russell Counties, Kansas, are subject to an option to purchase by owners of the remaining leasehold interests.

The Trustees, however, reserve the absolute right to reject any and all bids made during the public auction. A cashier's check, certified check, or cash equivalent to ten per cent (10%) of the total bid accepted shall be paid at the time of sale, and the balance due, upon approval of title, not to exceed ninety (90) days thereafter.

Information concerning the above-described properties, together with all engineering reports and production data, are available for examination by prospective bidders in the office of the Trust.

The interests in the above properties are being sold in accordance with Article VI of the Trust Indenture, dated December 7, 1935, as amended, under which said Trust was created. Article XIX provides that the Trust shall terminate at the expiration of twenty years, and the Trustees shall immediately proceed to liquidate and wind up the affairs of the Trust.

DATED at Tulsa, Oklahoma, this 25th day of October, 1955.

Wm. B. Prugh, J. D. Land
"Trustees"

NOTICE OF SALE OF INTERESTS IN PRODUCING OIL AND GAS PROPERTIES

Notice is hereby given that the undersigned, Wm. B. Prugh and J. D. Land, Trustees of LARKINS-WARR TRUST, an Express Trust organized under the laws of the State of Oklahoma, will offer for sale at public auction and sell to the highest bidder, for cash, the interests of Larkins-Warr Trust, an Express Trust, in four producing oil leases located in the Oklahoma City field, on the 12th day of December, 1955, at 10 o'clock a. m.

The interests of the Trust in the following properties will be combined and sold as a single unit, to-wit:

		Fractional Interest	Net Interest
1 Producing Well	Carney Lease	1/8 of ⅞ W.I.	58.33333
1 Producing Well	Goodwin Lease	1/8 of ⅞ W.I.	58.33333
1 Producing Well	Katy B-4 Lease	1/8 of ⅞ W.I.	58.33333
1 Producing Well	Travis Lease	1/8 of ⅞ W.I.	58.33333

These four wells produced 29,733 gross barrels of oil for the first nine months of 1955.

The undersigned Trustees will sell at public auction the above-described interests of Larkins-Warr Trust in the office of the Trust, 907 Kennedy Building, Tulsa 3, Oklahoma, on the 12th day of December, 1955 at 10 o'clock a. m. The Trustees, however, reserve the absolute right to reject any and all bids. A cashier's check, certified check, or cash equivalent to ten per cent (10%) of the total bid accepted shall be paid at the time of sale and the balance due upon approval of title not to exceed ninety (90) days thereafter.

Information concerning the above-described leases, together with all engineering reports and production data, are available for examination by prospective bidders in the office of the Trust.

The interests in the above leases are being sold in accordance with Article VI of the Trust Indenture, dated November 1, 1934, under which said Trust was created. Article VI provides that the Trust shall terminate at the expiration of a twenty-one (21) year period, and the Trustees will then proceed to liquidate and wind up the affairs of the Trust.

DATED at Tulsa, Oklahoma, this 25th day of October, 1955

Wm. B. Prugh, J. D. Land
"Trustees"

LEGAL

Sealed bids will be received until 1:00 P. M., Friday, December 16, 1955, and opened at that time at the Shawnee Indian Sub-Agency for the leasing of allotted Indian lands located in Pottawatomie, Cleveland, Lincoln, Logan and Payne Counties, Oklahoma, for oil and gas mining purposes. For additional information write or telephone Mr. Robert D. Grover, Area Field Representative, Shawnee, Oklahoma (Telephone No. 318).

LEGAL

SEALED BIDS FOR OIL AND GAS leases on the Crow Indian Reservation, Montana, will be received in the Office of the Superintendent, Crow Indian Agency, Crow Agency, Montana, until 2:00 o'clock (M.S.T.), Wednesday, December 7, 1955 at which time they will be opened and publicly read. Twenty (20) Units involving 7,212.73 acres of trust Indian Lands, a portion of which mineral rights are reserved for the benefit of the Crow Tribe by Act of Congress, will be offered. For further detailed information and list of lands advertised call or write, L. C. Lippert, Superintendent, Crow Indian Agency, Crow Agency, Montana.

LEGAL

Sealed bids will be received until December 14, 2:00 P. M. Mountain Standard Time, and opened at that time in the office of the Superintendent, Fort Belknap Consolidated Agency, Harlem, Montana, for the leasing of 1,288.34 acres of Tribal land and 19,003.90 acres of allotted Indian land located in Township 28 North, and Ranges 24 and 25 East, Principal Meridian, Montana, County of Blaine, Montana for oil and gas mining purposes. For further detailed information and a list of lands advertised call or write: Darrell Fleming, Superintendent, Fort Belknap Consolidated Agency, Harlem, Montana. Telephone 5R-1.

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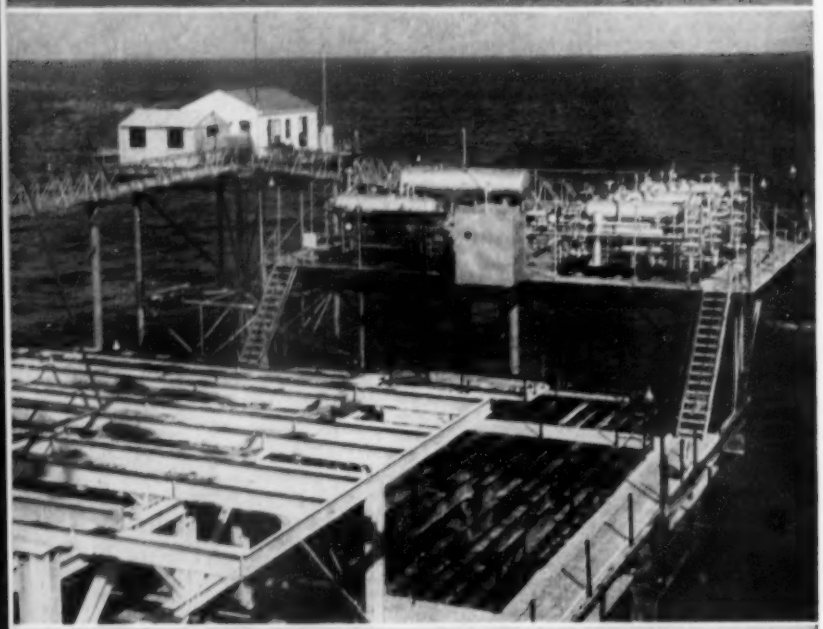

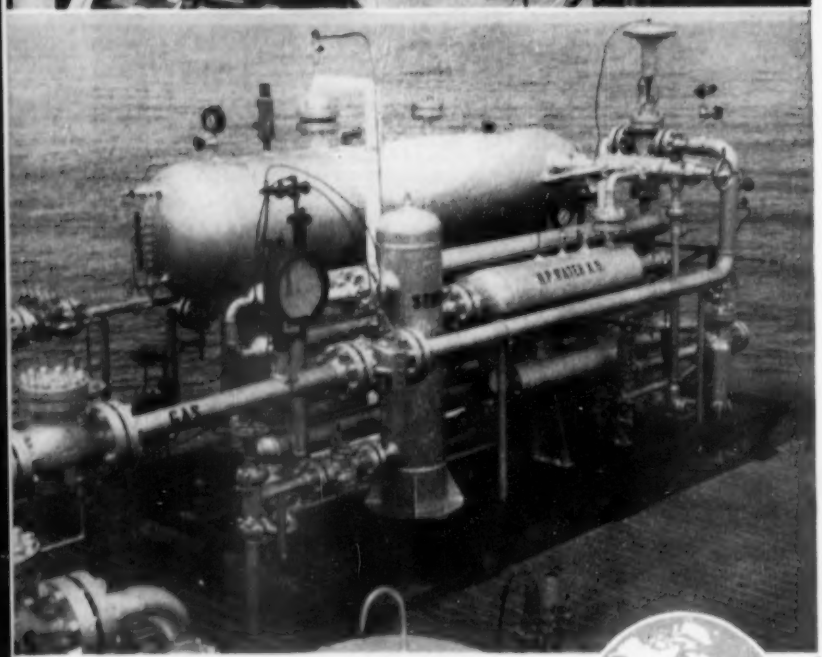

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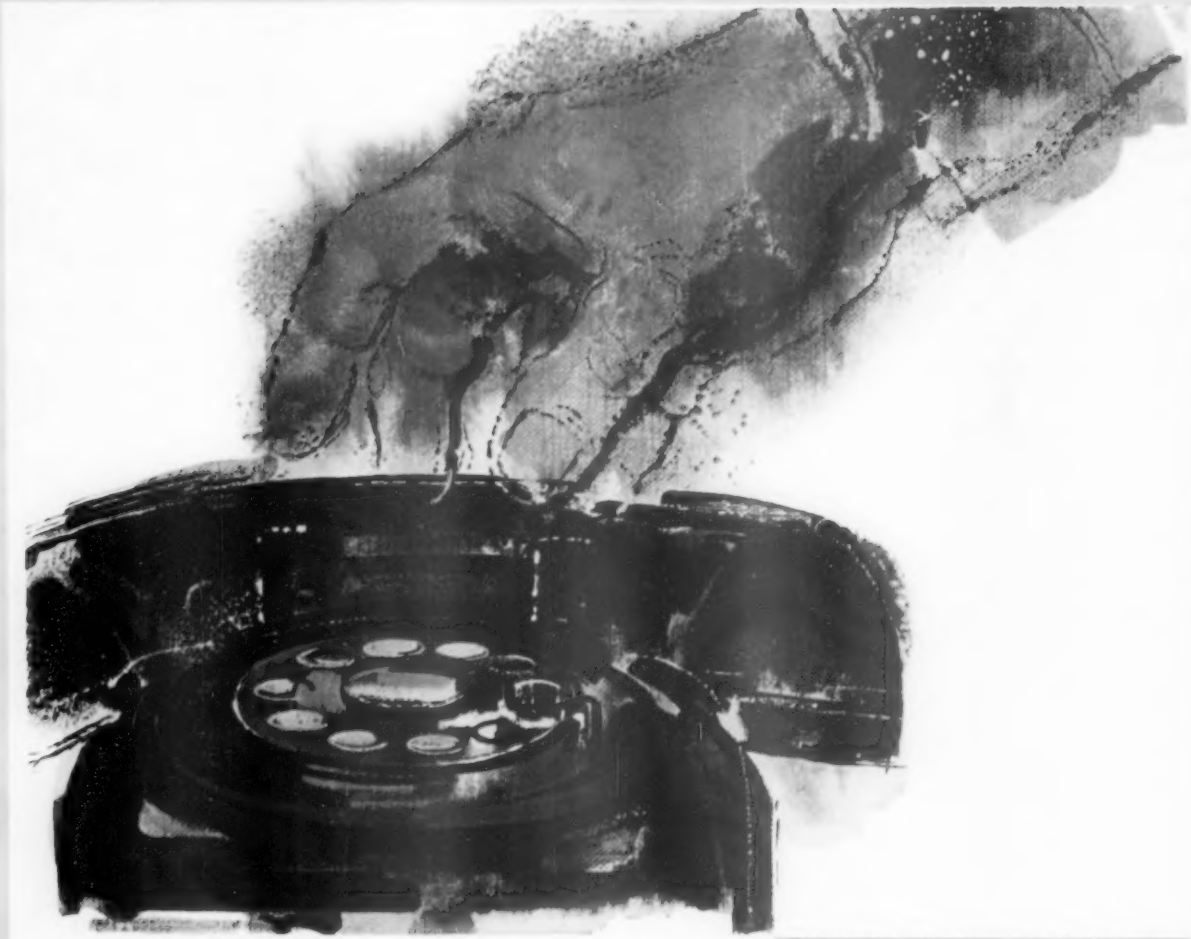

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